AC NO: AC 150/5340-14B

DATE: 6/19/70

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: ECONOMY APPROACH LIGHTING AIDS

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1. PURPOSE. This advisory circular describes standards for the design, selection, siting, and maintenance of those economy approach lighting aids which are eligible for installation under the Federal-aid Airport Program (FAAP) as described in Federal Aviation Regulations (FAR) Part 151.87(j). The advisory circular also provides general guidance to the public for these approach lighting aids.

2. CANCELLATIONS.

   a. AC 150/5340-14A, Economy Approach Lighting Aids, dated 7 March 1967.

   b. AC 150/5345-24, Specification for L-849 Condenser Discharge Type Flashing Light, dated 30 June 1965.

   c. AC 150/5345-25, Specification for L-848 Medium Intensity Approach Light Bar Assembly, dated 30 June 1965.

   d. AC 150/5345-40, Specification for L-854 Radio Controls, dated 21 March 1969.

3. RELATED READING MATERIAL. The publications listed under Appendix 3, Bibliography, are applicable to this advisory circular.

4. EXPLANATION OF REVISIONS. In addition to minor changes in the text and figures, the following have been included:

   a. Tolerance, frangibility, and construction details for Medium Intensity Approach Light System With Sequenced Flashing Lights (MALSF).

   b. Aiming criteria for Runway End Identifier Lights (REIL).

   c. Construction details for 2-box Visual Approach Slope Indicator (VASI).

Initiated by: AAS-200

d. Details for lighting requirements in runway safety areas were added to the appendices.

e. References to FAA Handbooks 6850.2, Visual Guidance Lighting Systems, and 6850.3, Visual Guidance Lighting Systems Installation Drawings, were added to the appendices.

f. Recommendations for flight checking economy approach lighting aids were added to the appendices.

g. Additional maintenance details were included to the appendices.

h. Economy approach lighting aids equipment specifications L-848, L-849, and L-854 were added to the appendices.

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1. INTRODUCTION.

   a. The economy approach lighting aids were developed to make available to eligible airports low cost approach visual aids. The design and installation requirements are flexible to permit the equipment to be installed and operated with minimum changes to the power distribution system at the airport.

   b. The technical information required to plan and install a system is included in Figures 1 through 12. These are drawings of TYPICAL installations. Local applications may require variations from the drawings, but no variations in the layout, spacing, and tolerances are permitted. Although it is possible to plan an installation from the drawings, various characteristics affecting the systems and their design, equipment, and installation deserve special consideration.

2. TYPES OF ECONOMY APPROACH LIGHTING AIDS.

   a. Medium Intensity Approach Lighting System With or Without Sequenced Flashing Lights (MALSF or MALS). If medium intensity approach lights are to be installed without sequenced flashing lights, apply only the applicable portions of the paragraphs for MALSF.

   b. Runway End Identifier Lights (REIL).

   c. 2-Box Visual Approach Slope Indicator (2-Box VASI). This system is also referred to as abbreviated visual approach slope indicator (AVASI or VASI-2).

3. SELECTION CONSIDERATIONS. Select a particular system on the basis of an operational requirement for light signals in addition to runway edge lights. Consider the following when selecting an economy approach lighting aid:

   a. The airport's current operations and forecasts for three years indicate that the airport will not meet the criteria under the agency's planning standards for the installation of an instrument landing system/approach lighting system (ILS/ALS), runway end identifier lights (REIL), or visual approach slope indicator system (VASI). See the paragraphs below for a listing of agency-owned approach lighting systems. (Configurations and design details pertaining to these systems are contained in FAA Handbooks 6850.2 and 6850.3.)

(1) Medium Intensity Approach Lighting System (MALS).

(2) Medium Intensity Approach Lighting System with Sequenced Flashers (MALSF).

(3) Simplified Short Approach Lighting System (SSALS).

(4) Simplified Short Approach Lighting System with Sequenced Flashers (SSALF).

(5) Medium Intensity Approach Lighting System with Runway Alignment Indicator Lights (MALSR).

(6) Simplified Short Approach Lighting System with Runway Alignment Indicator Lights (SSALR).

(7) Standard 3000-Foot High Intensity ALS with Sequenced Flashers, Category I Configuration (ALSF-1).

(8) Standard 3000-Foot High Intensity ALS with Sequenced Flashers, Category II Configuration (ALSF-2).

b. The runway to be served has at least a medium intensity runway lighting system.

c. If MALSF is to be installed, the airport should have assigned, or have the potential for, an instrument approach procedure other than instrument landing system/precision approach radar (ILS/PAR).

d. MALSF and REIL are not installed on the same end of a runway. If required, install the 2-box VASI with either MALSF or REIL on the same end of a runway.

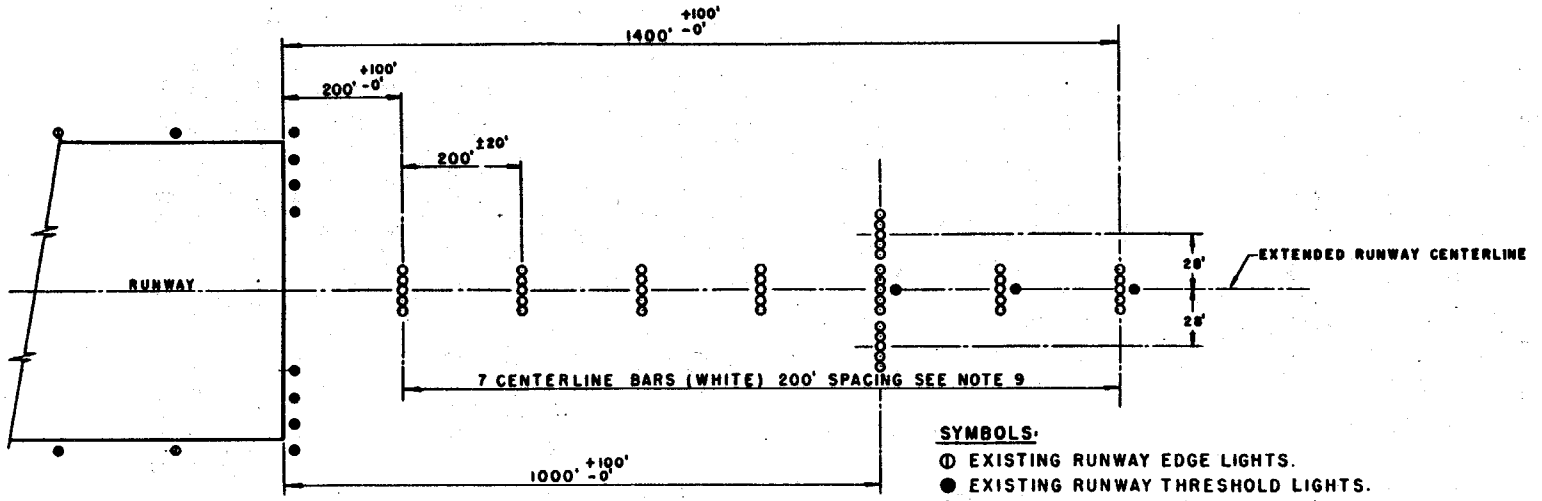
e. MALSF are not installed at locations where semiflush approach light fixtures are required.

f. Prior to the selection of a particular lighting aid, discuss with local FAA personnel operational and environmental needs of the individual site. See Appendix 2 for a listing of FAA offices. In addition, make an individual site evaluation to determine which aid will best serve in reducing the deficiency(s) in a particular area. Reduction to instrument approach minima may be made in accordance with the U.S. Standard for Terminal Instrument Procedures. Use the following information as a guide for selecting a particular system.

(1) MALSF. This system provides early runway lineup and lead-in guidance, runway end identification, and to a degree, roll guidance. The lights are helpful during some periods of restricted visibility. The MALS is beneficial where extraneous lighting prevents the pilot from lining up with the runway centerline or where the surrounding terrain is devoid of lighting and does not provide the cues necessary for proper aircraft attitude control. At locations where approach area identification is difficult at night due to surrounding lights, MALS with sequenced flashing lights installed at the three outermost bars should resolve this problem. FAAP installations are limited to MALSF; however, the design MALSF permits a later expansion to MALSR with the installation of extra flashers at some cost other than to FAAP. See FAA Handbooks 6850.2 and 6850.3 for details on MALSR.

* (2) REIL. These lights aid in early identification of the runway and runway end. They are more beneficial in areas having a large concentration of lights and in areas of featureless terrain. These lights should be installed where there is only a circling approach or a circling and nonprecision straight-in approach. The omnidirectional REIL provides good circling guidance and is the preferred system. The unidirectional REIL should be installed where environmental conditions require that the area affected by the flash from the REIL be greatly limited.*

(3) 2-Box VASI. This system provides visual approach slope guidance. On runways not provided with electronic guidance, the light signals are beneficial in aiding the pilot of an aircraft to determine his correct glide slope. The presence of objects in the approach area may involve a serious hazard if an aircraft descends below the normal path. This is especially true where sources of visual reference information are lacking or deceptive, i.e., hilltops, valleys, terrain grades, and remote-type airports. The 2-box VASI assists the pilot in maintaining a safe distance above hazardous objects. The 2-box VASI has been found useful for noise abatement purposes by providing a visual glide slope so that the necessity for the addition of surges of power during final approaches to land can be avoided. The visual aiming point obtained with the 2-box VASI reduces the probability of undershoots or overshoots. FAAP installations are limited to 2 boxes; however, this basic system could be expanded to 4 boxes (at some cost other than FAAP) if jet operations are introduced at a later date. Details for 4-box VASI installations are contained in FAA Handbooks 6850.2 and 6850.3.



SYMBOLS:

- ⊕ EXISTING RUNWAY EDGE LIGHTS.
- ● EXISTING RUNWAY THRESHOLD LIGHTS.
- ○ STEADY BURNING APPROACH LIGHTS.
- ⊗ SEQUENCED FLASHING LIGHTS

NOTES:

1. THE OPTIMUM LOCATION OF THE APPROACH LIGHTS IS IN A HORIZONTAL PLANE AT RUNWAY END ELEVATION. PROVIDE AT LEAST THREE CONSECUTIVE LIGHT BAR STATIONS IN A SLOPING SEGMENT OF THE SYSTEM. THE SLOPING SEGMENT MAY START AT THE FIRST LIGHT BAR AND EXTEND TO THE END OF SYSTEM OR MAY BE PRECEDED BY A HORIZONTAL SEGMENT OR FOLLOWED BY EITHER A HORIZONTAL OR NEGATIVE SLOPING SEGMENT.
2. A MAXIMUM 2 PERCENT UPWARD LONGITUDINAL SLOPE TOLERANCE MAY BE USED TO RAISE THE LIGHT PATTERN ABOVE OBJECTS WITHIN ITS AREA.
3. A MAXIMUM 1 PERCENT DOWNWARD LONGITUDINAL SLOPE TOLERANCE MAY BE USED TO REDUCE THE HEIGHT OF SUPPORTING STRUCTURES.
4. ALL STEADY BURNING AND FLASHING LIGHTS ARE AIMED WITH THEIR BEAM AXES PARALLEL TO THE RUNWAY CENTERLINE AND INTERCEPTING AN ASSUMED 3° GLIDE SLOPE (INTERCEPTING THE RUNWAY 1000 FEET FROM THE LANDING THRESHOLD) AT A HORIZONTAL DISTANCE OF 1600 FEET IN ADVANCE OF THE LIGHT.
5. ALL OBSTRUCTIONS AS DETERMINED BY APPLICABLE CRITERIA (FAR PART 77) FOR DETERMINING OBSTRUCTIONS TO AIR NAVIGATION ARE LIGHTED AND MARKED AS REQUIRED.
6. ALL STEADY BURNING AND FLASHING LIGHTS IN THE SYSTEM EMIT WHITE LIGHT.
7. INTENSITY CONTROL IS PROVIDED FOR THE STEADY BURNING LIGHTS.
8. THE THREE FLASHING LIGHTS FLASH IN SEQUENCE.
9. THE MALS LIGHT BAR CLOSEST TO THE RUNWAY THRESHOLD IS LOCATED AT A DISTANCE OF $200'^{+100'}_{-0'}$ ALL OTHER LIGHT BARS SHOULD BE INSTALLED AT 200' INTERVALS WITH A ±20' TOLERANCE AT EACH LIGHT BAR STATION. THE ABOVE TOLERANCES MAY BE USED WHERE IT IS IMPRACTICAL TO INSTALL LIGHT BARS AT THE OPTIMUM LOCATIONS.
10. THE MINIMUM LAND REQUIREMENTS FOR MALSF IS AN AREA 1600' IN LENGTH BY 400' WIDE.
11. PROVIDE A CLEAR LINE OF SIGHT TO ALL LIGHTS OF THE SYSTEM FROM ANY POINT ON A SURFACE $\frac{1}{2}$° BELOW A 3° GLIDE PATH, INTERSECTING THE RUNWAY 1000' FROM THE LANDING THRESHOLD. SEE FIG. 10 FOR COVERAGE OF LINE OF SIGHT.

FIGURE 1. TYPICAL LAYOUT FOR MALSF

4. CONFIGURATIONS.

a. MALSF.

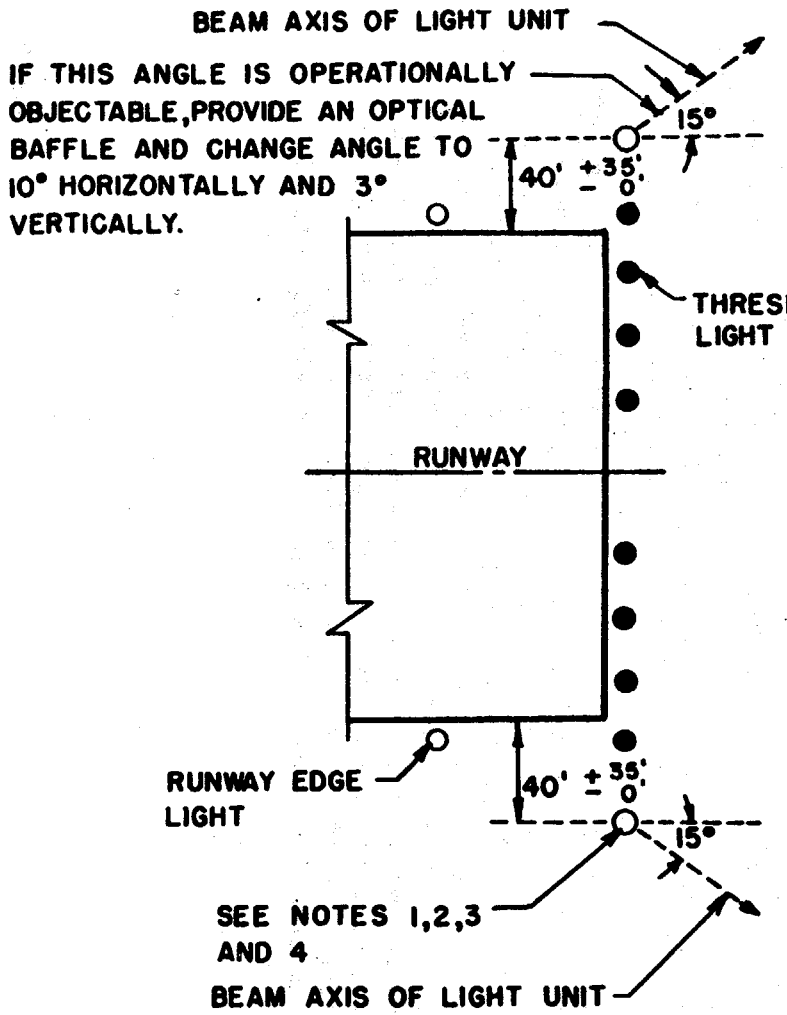
(1) Provide a configuration of steady burning and flashing lights arranged symmetrically about and along the extended runway centerline as shown in Figure 1. Begin the system approximately 200 feet from the runway threshold and extend it to an approximate 1400-foot overall length.

(2) Use seven light stations with five steady burning lights at each station. If required, provide one flashing light at each of the three outermost stations. At the station 1,000 feet from the runway threshold, use two additional bars (one on each side of the centerline bar) each with five steady burning lights.

(3) All lights in the system emit white light. Provide intensity control for steady burning lights. Flashing lights have no intensity control.

b. REIL. Provide two flashing lights near the end of the runway as shown in Figure 2. Locate the lights (optimumly) in line with the runway threshold, 40 feet out on each side of the runway edge. Orient the beam axis of unbaffled unit 15 degrees outward from a line parallel to the runway and inclined at an angle 10 degrees above the horizontal. If this standard setting is operationally objectionable, provide optical baffles and orient the beam axis of the unit 10 degrees outward from a line parallel to the runway centerline and inclined at an angle of 3 degrees above the horizontal. Details pertaining to baffles are contained in Specification L-849. The REIL's emit white light and have no intensity control.

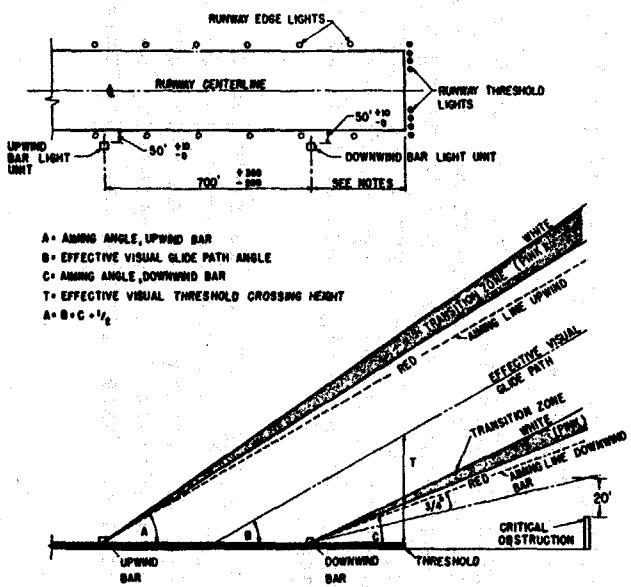
c. 2-Box VASI. Provide two light units located 50 feet from the left runway edge when the optical system is viewed from the approach zone. The light units are installed in a line parallel with the runway edge. Each light unit emits a two-color (red and white) light beam. When the light units are properly aimed, the optical systems provide visual approach slope information. When airport paved surfaces prevent the normal left side installation or when significant cost reductions can be realized, install the system on the right side of the runway and publish this fact in the Airman's Information Manual. See Figure 3 for aiming criteria.



NOTES

1. THE OPTIMUM LOCATION FOR EACH LIGHT UNIT IS IN LINE WITH THE RUNWAY THRESHOLD AT 40 FEET FROM THE RUNWAY EDGE.
2. A PLUS OR MINUS 200-FOOT TOLERANCE IS PERMITTED IN LOCATING THE LIGHT UNITS IN LINE WITH THE RUNWAY THRESHOLD.
3. THE LIGHT UNITS ARE EQUALLY SPACED WITH RESPECT TO EACH OTHER, FROM THE RUNWAY THRESHOLD.
4. THE BEAM CENTERLINE OF EACH LIGHT UNIT IS AIMED 15° OUTWARD FROM A LINE PARALLEL TO THE RUNWAY CENTERLINE AND INCLINED AT AN ANGLE 10° ABOVE THE HORIZONTAL.
5. LOCATE THE REIL EQUIPMENT NOT LESS 10 FEET FROM TAXIWAYS.
6. IF REILS ARE USED WITH VASI-2, INSTALL REILS AT 75' LOCATION.

FIGURE 2. TYPICAL LAYOUT FOR REIL



NOTES:

1. INSTALL THE UPWIND AND DOWNWIND BAR LIGHT UNITS AN EQUAL DISTANCE FROM THE RUNWAY EDGE.
2. LOCATE THE CENTER OF THE OPTICAL APERTURE OF THE INSTALLED UPWIND AND DOWNWIND BAR LIGHT UNITS WITHIN PLUS OR MINUS ONE FOOT OF THE RUNWAY CROWN.
3. LOCATE THE LIGHT UNIT IN EACH BAR ON A LINE PERPENDICULAR TO THE RUNWAY CENTERLINE. PLACE THE FRONT FACE OF EACH LIGHT UNIT WITHIN A TOLERANCE OF ±6 INCHES FROM THIS LINE.
4. ALIGN EACH LIGHT UNIT OUTWARD INTO THE APPROACH ZONE ON A LINE PARALLEL TO THE RUNWAY CENTERLINE WITHIN A TOLERANCE OF PLUS OR MINUS ½ DEGREE.
5. AIM THE DOWNWIND AND UPWIND LIGHT UNITS IN ACCORDANCE WITH THE EQUIPMENT MANUFACTURER'S INSTRUCTIONS WITHIN ±2 MINUTES OF THE RESPECTIVE ANGLE FORMED BY LINE A AND THE RUNWAY SURFACE, AND LINE C AND THE RUNWAY SURFACE.
6. DETERMINE THE EFFECTIVE VISUAL GLIDE PATH OF THE SYSTEM BY THE STEPS LISTED BELOW.
   a. MAKE A PLOT OF THE APPROACH AREA SHOWING THE LOCATION AND HEIGHTS OF ALL OBSTRUCTIONS.
   b. DRAW A LINE FROM THE DOWNWIND BAR LOCATION TO 20 FEET ABOVE THE MOST CRITICAL OBSTRUCTION IN THE AREA SEE ABOVE FIGURE.
   c. AIM THE DOWNWIND BAR AT AN ANGLE EQUAL TO THAT OBTAINED IN NOTE b ABOVE PLUS ¾ DEGREE.
   d. AIM THE UPWIND BAR IN ACCORDANCE WITH THE EQUIPMENT MANUFACTURER'S INSTRUCTIONS ½ DEGREE ABOVE THE DOWNWIND BAR.
   e. THE EFFECTIVE GLIDE PATH OF THE SYSTEM (ANGLE B) IS EQUAL TO THE AIMING OF THE UPWIND BAR.
7. LOCATE THE DOWNWIND BAR 125 FEET TO 800 FEET FROM THE RUNWAY APPROACH THRESHOLD.
8. WHERE TERRAIN DROPS OFF RAPIDLY NEAR THE APPROACH THRESHOLD AND SEVERE TURBULENCE MAY BE EXPERIENCED, ESTABLISHED THE EFFECTIVE GLIDE PATH AT ITS MAXIMUM ELEVATION AND DOWNWIND BAR LOCATED ITS MAXIMUM DISTANCE FROM THE LANDING THRESHOLD IN ORDER TO KEEP AIRCRAFT AS HIGH AS FEASIBLE OVER THE LANDING THRESHOLD.
9. THE MINIMUM EFFECTIVE VISUAL GLIDE PATH IS 2.5 DEGREES. THE MAXIMUM EFFECTIVE VISUAL GLIDE PATH IS 4° FOR PROPELLER DRIVEN AIRCRAFT.
10. LIGHT AND MARK ALL OBSTRUCTIONS AS REQUIRED (FAR PART 77).
11. AT LOCATIONS WHERE SNOWFALL IS LIKELY TO OBSCURE THE LIGHTS, THE LIGHT UNITS MAY BE INSTALLED UP TO A MAXIMUM HEIGHT OF 6 FEET ABOVE GROUND LEVEL. SINCE RAISING THE LIGHT UNITS ALSO RAISES THE EFFECTIVE VISUAL GLIDE PATH, THE UPWIND AND DOWNWIND BARS SHOULD BE RELOCATED DOWNWIND A DISTANCE SUFFICIENT TO COMPENSATE FOR THIS. THE DISTANCE THE BARS SHALL BE MOVED IS DETERMINED FROM THE FOLLOWING FORMULA: $d = \frac{h}{TAN\theta}$ WHERE

    d= DISTANCE IN FEET BOTH BARS SHOULD BE MOVED TOWARD THRESHOLD.
    θ= VISUAL GLIDE PATH ANGLE
    h= THE DIFFERENCE BETWEEN THE AVERAGE ELEVATION OF THE UPWIND AND DOWNWIND BARS FROM THE ELEVATION OF A POINT ON THE RUNWAY CENTERLINE MIDWAY BETWEEN THE UPWIND AND DOWNWIND BARS.
12. AT LOCATION WHERE 2-BOX VASI INSTALLATIONS CAN NOT BE ON THE LEFT SIDE, INSTALL THE LIGHT UNITS ON THE RIGHT SIDE OF THE RUNWAY AND PUBLISH THIS FACT IN THE AIRMAN'S INFORMATION MANUAL.
13. THE MINIMUM AND MAXIMUM THRESHOLD CLEARANCE OF THE EFFECTIVE VISUAL GLIDE PATH IS 25 FEET AND 60 FEET RESPECTIVELY. WHERE THE DISTANCE BETWEEN PILOT'S EYE AND THE LOWEST PORTION OF THE AIRCRAFT IN LANDING ATTITUDE EXCEEDS 10 FEET, THE MINIMUM THRESHOLD CROSSING HEIGHT IS INCREASED BY AN AMOUNT EQUAL TO THAT IN EXCESS OF THE 10 FEET.

FIGURE 3. TWO-BOX VASI LAYOUT, INSTALLATION AND AIMING CRITERIA

5. DESIGN.

a. MALSF.

(1) Electrical Systems. The basic electrical system's design is identified by the method used to control the on-off operation of the lights. The controls available are remote, radio, and control from the runway edge lighting circuit. Select the type control best suited for the airport's operation.

(a) Remote Control. A typical remotely controlled system consists of on-off and brightness switches, control relays, distribution transformers, MALSF equipment, and interconnecting wires. See Figure 4 for a typical wiring diagram. Select this type control at locations with a controller. Normally the initial installation cost for remote controls is more than that for a system with radio controls or controls from the runway lighting circuit.

(b) Radio Control. Use the system wiring diagram shown in Figure 4 with the exceptions listed below. Select radio controls if the lights are needed for short duration (less than 15 minutes at a time).

1 Locate the Specification L-854 receiver near the MALSF to eliminate costly underground cables.

2 Substitute the L-854 radio controls for the on-off switch shown in Figure 4 and use a control relay with a coil compatible with the output of the L-854 receiver.

3 Use a photoelectric device in lieu of the high-low switch shown in Figure 4.

(c) Runway Lighting Circuit Control. See Figure 5 for a typical system controlled from the runway edge lighting circuit. Use components such as an insulating transformer, a series control device, and a distribution transformer in conjunction with the MALSF equipment to assure proper on-off operation. Select brightness control as specified in Handbook 6850.2.

(d) Power Supply and Wiring. Use a distribution transformer with a center tap to obtain the 120-volt and 60-volt input to the MALS' PAR 38 spotlights. As an alternate, use two distribution transformers with the necessary switching equipment to connect these transformers alternately

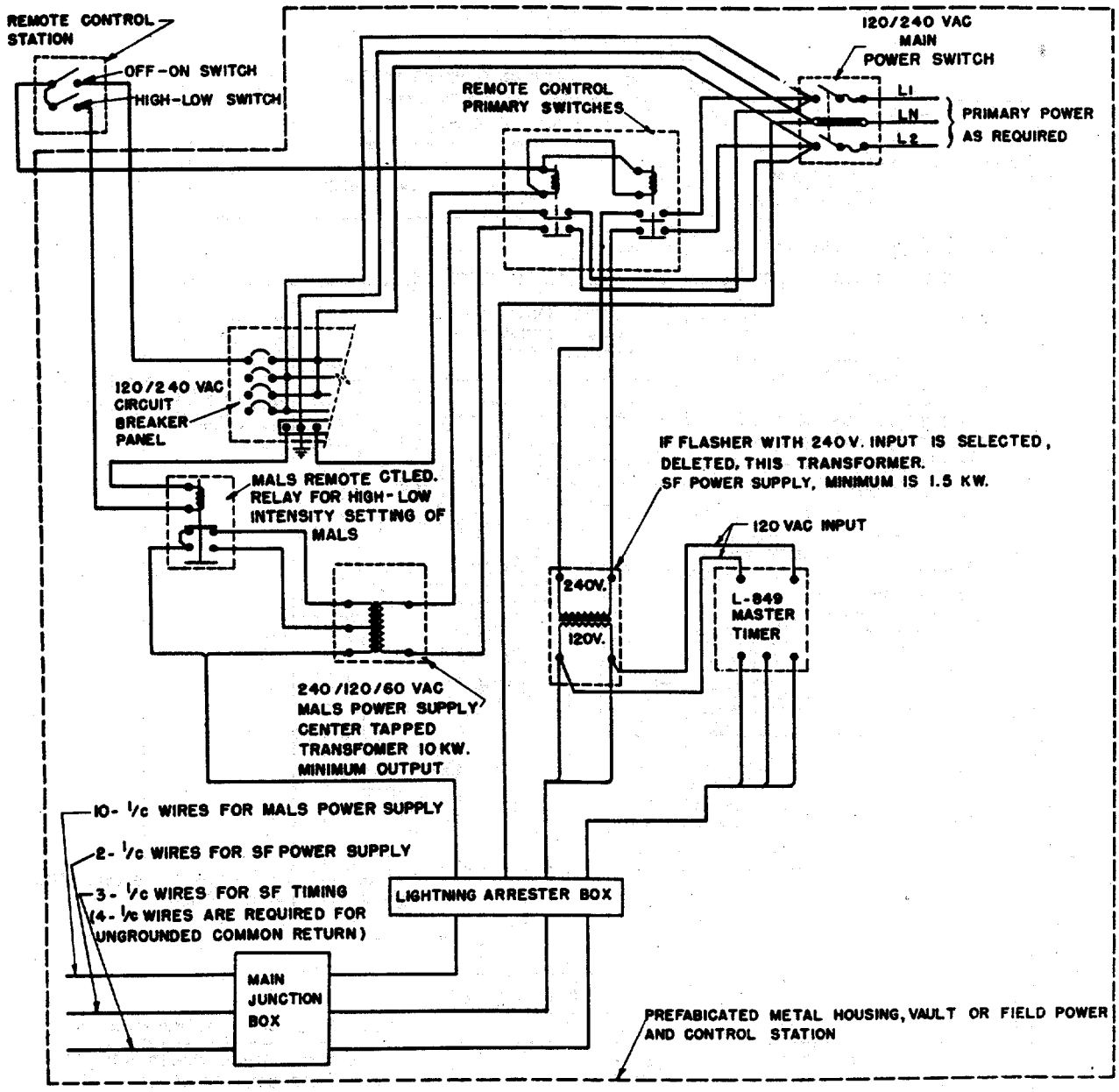


FIGURE 4. GENERAL WIRING DIAGRAM FOR MALSF WITH 120-VOLT, AC REMOTE CONTROL

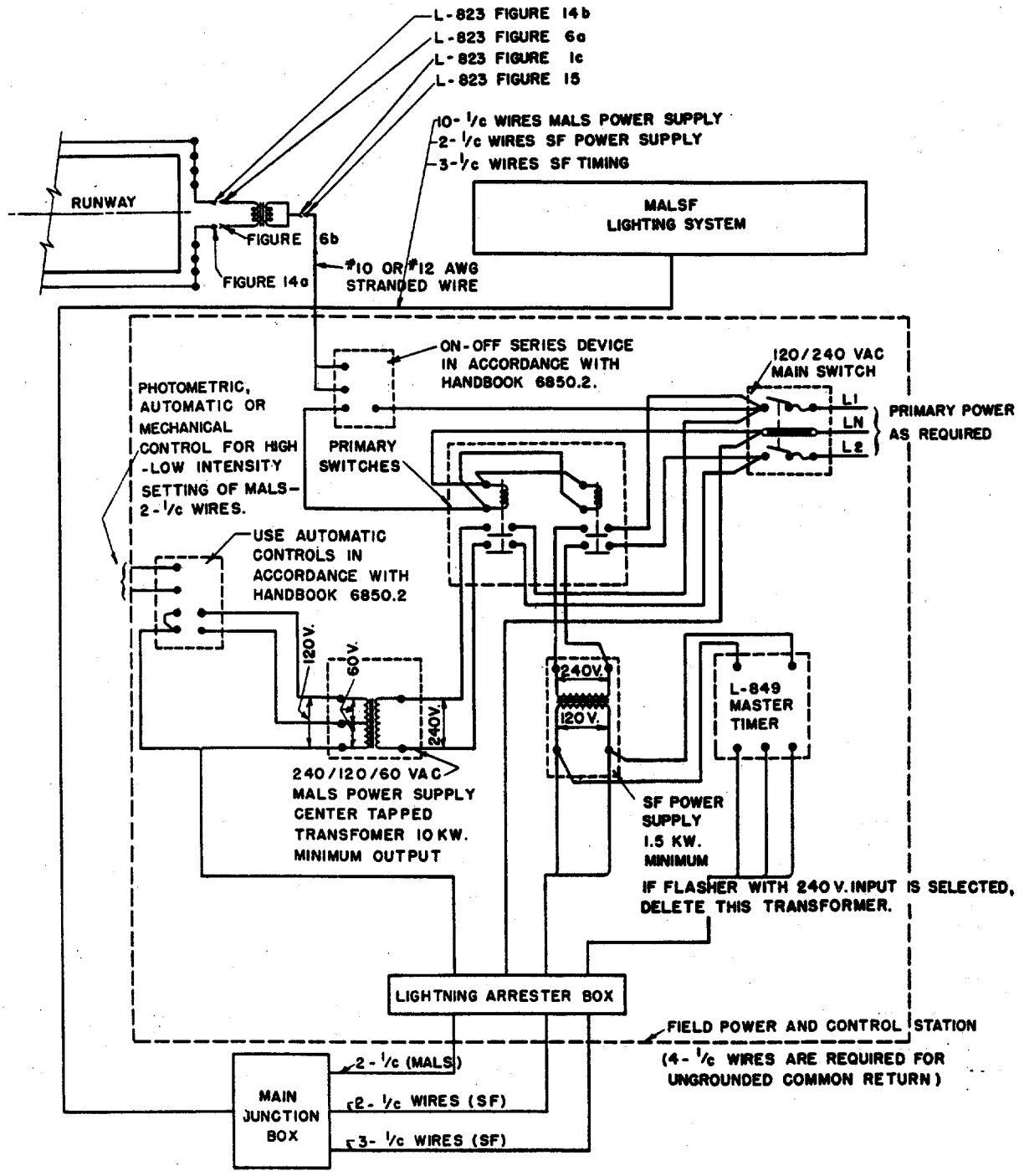


FIGURE 5. TYPICAL WIRING DIAGRAM FOR MALSF CONTROLLED FROM RUNWAY LIGHTING CIRCUIT

in series and parallel to obtain 120 volts and 60 volts across the MALS' PAR 38, 150-watt spotlights. Obtain the high setting of the MALS lamp with the 120 volts and the low setting with the 60 volts.

1 Transformer Rating. Obtain a transformer with a minimum rating of 10 kilowatts at 120 volts, 60 H_z. Use this power to supply the lamp load and field wiring shown in Figure 6. Select a transformer designed to carry rated load continuously under expected environmental conditions.

2 Field Wire Sizes. Calculate the minimum wire sizes for each installation. If the field wiring is similar to the typical layout shown in Figure 6, use a No. 4 AWG wire (maximum) for power circuits and a No. 19 AWG wire (minimum) for sequenced flashing lights timing circuits. Provide not less than 114 volts, 60 H_z nor more than 126 volts, 60 H_z at all steady burning and flashing MALSF lamps.

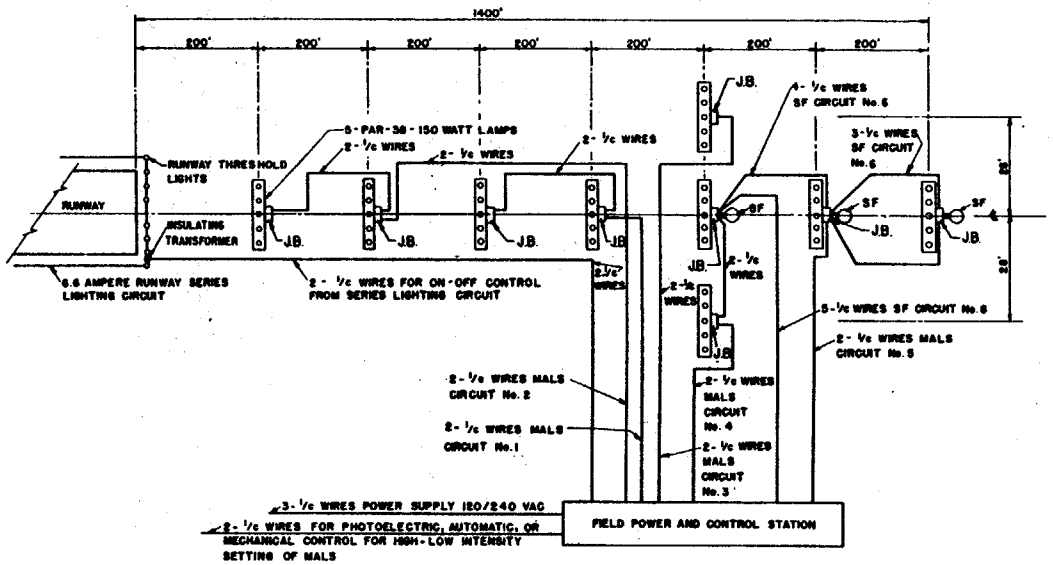
(2) Structures.

(a) Mount all lights in the inner 1,000-foot section of the MALSF (excluding station 10 + 00) on frangible structures.

(b) Limit the use of completely frangible structures to those locations where the distance from ground level to the lamp center is 6 feet or less. See paragraph 7d(6) for completely frangible structures.

(c) Use semi-frangible structures at all light stations in the inner 1,000-foot section of the MALSF (excluding station 10 + 00) where the distance from ground level to lamp center is over 6 feet. Semi-frangible structures have the upper 6-foot portion frangible and the remaining portion rigid. When a suitably graded runway safety area exists, semi-frangible fixtures will not be permitted in the inner 1,000-foot section of the MALS. See AC 150/5300-2A for details on runway safety areas.

(d) Select rigid structures for all light stations from station 10 + 00 to the end of the system if there is a cost or structural justification. Use frangible or semi-frangible structures in lieu of rigid structures where considered advisable for safety purposes. See paragraph 7d(7) for structural details.



NOTES:

1. THE INSTALLATION CONFORMS TO THE APPLICABLE SECTION OF THE NATIONAL ELECTRICAL CODE AND LOCAL CODES.
2. INSTALL LIGHTNING ARRESTERS FOR POWER AND CONTROL LINES AS REQUIRED.
3. WHERE REQUIRED INSTALL A COUNTERPOISE SYSTEM AS SPECIFIED IN THE PLANS.
4. INSTALL FUSES, CIRCUIT BREAKERS AND CUTOUTS IN ACCORDANCE WITH EQUIPMENT RATINGS
5. CALCULATE THE MINIMUM WIRE SIZE TO BE USED BETWEEN THE POWER SUPPLY, MAIN JUNCTION BOX, AND LIGHT BARS FOR EACH INSTALLATION.
6. INSTALL A MASTER TIMER IN ACCORDANCE WITH SPECIFICATION L-849.
7. CONNECT THE FLASHING LIGHTS AND THE STEADY BURNING LIGHTS INTO THE ELECTRICAL CIRCUITS IN ACCORDANCE WITH THE EQUIPMENT MANUFACTURERS' INSTRUCTIONS.
8. INSTALL THE PREFABRICATED METAL HOUSING AND THE EQUIPMENT IT ENCLOSES IN ACCORDANCE WITH APPLICABLE SECTIONS OF ADVISORY CIRCULAR 150/5340-9 PREFABRICATED METAL HOUSING FOR ELECTRICAL EQUIPMENT.
9. INSTALL AND CHECK THE UNDERGROUND CABLES IN ACCORDANCE WITH THE APPLICABLE SECTIONS OF ITEM L-108 OF ADVISORY CIRCULAR 150/5370-1A STANDARD SPECIFICATION FOR CONSTRUCTION OF AIRPORTS.
10. GROUND EACH LIGHT BAR AND FLASHING LIGHT AS SPECIFIED IN THE INSTALLATION PLANS.
11. MAINTAIN NOT LESS THAN 114 VOLTS Hz NOR MORE THAN 126 VOLTS Hz AT LIGHTS.
12. A TYPICAL LOCATION FOR THE FIELD POWER AND CONTROL STATION IS NEAR THE 1000 FOOT CROSS BAR. DO NOT INSTALL THE FIELD POWER AND CONTROL STATION CLOSER THAN 400 FEET TO THE MALS CENTERLINE BETWEEN STATION 0+00 AND 10+00.
13. ALL JUNCTION BOXES (JB) ARE FURNISHED BY THE INSTALLATION CONTRACTOR.
14. POWER CIRCUITS ARE ASSIGNED NUMBERS 1-6 FOR REFERENCE PURPOSES

FIGURE 6. TYPICAL FIELD WIRING CIRCUITS FOR MALSF

b. REIL.

(1) Electrical Systems. Design the system to permit operation of the light units within the rated tolerances of the equipment. Select light units that operate in a multiple circuit or series circuit. See paragraph 6h(1) for the type units available for installation.

(a) Controls. Control the operation of the light units with one of the methods listed below:

1 Remote Controls. Provide an on-off switch as shown in Figure 7 at a remote location. Use this switch to control the input power to the light unit. Select a switch rated to continuously carry the required rated load.

2 Radio Controls. Use the L-854 receiver in conjunction with a pilot relay to control the light units. Select a relay with contacts rated to continuously carry the required rated load.

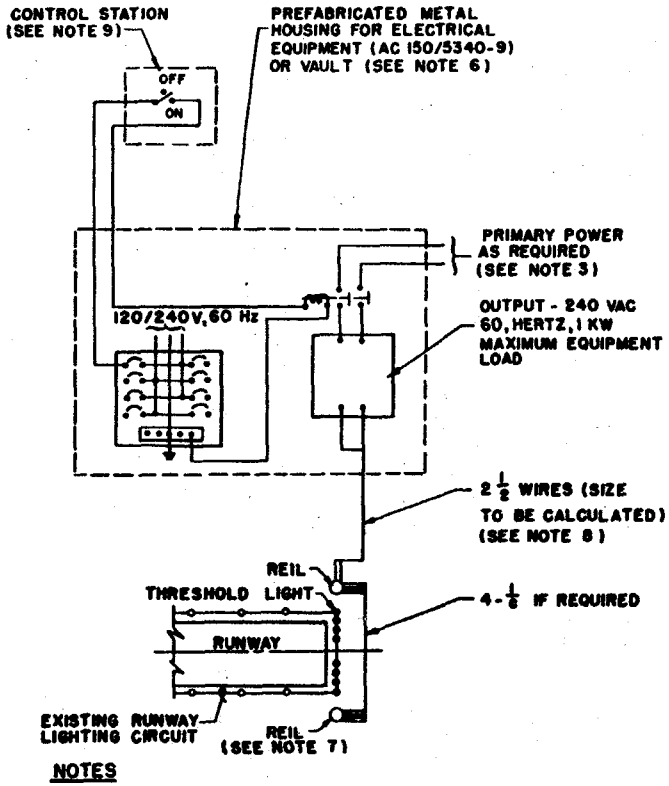
3 Runway Regulator Controls. See Figure 8 for a typical installation of REILS in a series circuit. Provide a selector switch to permit the independent control of the REILS even though the REILS share a common power source with the runway edge lights.

(b) Power Supply and Wiring. Use a source capable of producing 120 volts $\pm$ 6 volts, 60 H_z volts or 240 volts $\pm$ 12 volts, 60 H_z at the terminal of a 1.3 kilowatt inductive load. Calculate the wire size used to connect the multiple light units to the source voltage. See Figure 7 for a typical example. Use 5KV, No. 8 AWG cables for connecting REILS into series circuits, unless otherwise specified.

(2) Structures. See paragraph 7e for REIL structure installation details. Use a 2.197 inch or 2.375 inch outside diameter pipe support to secure the light unit.

c. 2-Box VASI.

(1) Electrical Systems. Select equipment and connect the light units for continuous operation, series operation, or operation from a multiple circuit. See Figure 9 for typical wiring diagrams.



NOTES

1. THE INSTALLATIONS SHOULD CONFORM TO THE APPLICABLE SECTIONS OF THE NATIONAL ELECTRICAL CODE AND LOCAL CODES.
2. LIGHTING ARRESTERS FOR POWER AND CONTROL LINES SHOULD BE INSTALLED AS REQUIRED.
3. FUSES AND CIRCUIT BREAKERS SHOULD BE IN ACCORDANCE WITH EQUIPMENT RATINGS.
4. THE RUNWAY END IDENTIFIER LIGHT SYSTEM IS GROUNDED AS SPECIFIED IN THE PLANS FOR THE INSTALLATION.
5. LOCAL CONTROL CAN BE OBTAINED FOR REILS IF REQUIRED FOR THE INSTALLATION. THE LOCAL SWITCH IS AS SPECIFIED IN SPEC. L-849.
6. NO ENCLOSURE IS REQUIRED IF THE EQUIPMENT SHOWN IN THE HOUSING IS DESIGNED FOR OUTDOOR SERVICE
7. THE LIGHT UNITS AND LOCAL CONTROLS ARE IN ACCORDANCE WITH SPECIFICATION L-849.
8. SAMPLE CALCULATION TO DETERMINE THE MAXIMUM DISTANCE BETWEEN THE DISTRIBUTION TRANSFORMER AND THE FURTHEST REILS LIGHT UNIT USING No. 12 AWG WIRE (RESISTANCE = 1.62 OHMS/1000').

   a. LOCAL CONDITIONS

   (1). LOAD OF 2 REILS LIGHT UNITS - 1KW MAXIMUM.

   (2). AVAILABLE VOLTAGE FROM DISTRIBUTION TRANSFORMER FOR REILS - 240 VOLTS ± 5%.

   b. CALCULATIONS

   (1). $\frac{500 \text{ WATTS/LIGHT UNIT} \times 2 \text{ LIGHT UNITS}}{240 \text{ VOLTS}} = 4.16$ AMPERES LOAD CURRENT

   (2). 240 X 5% = 12 VOLTS PERMISSIBLE LINE LOSS TO HAVE RATED VOLTAGE AT FURTHEST FIXTURE.

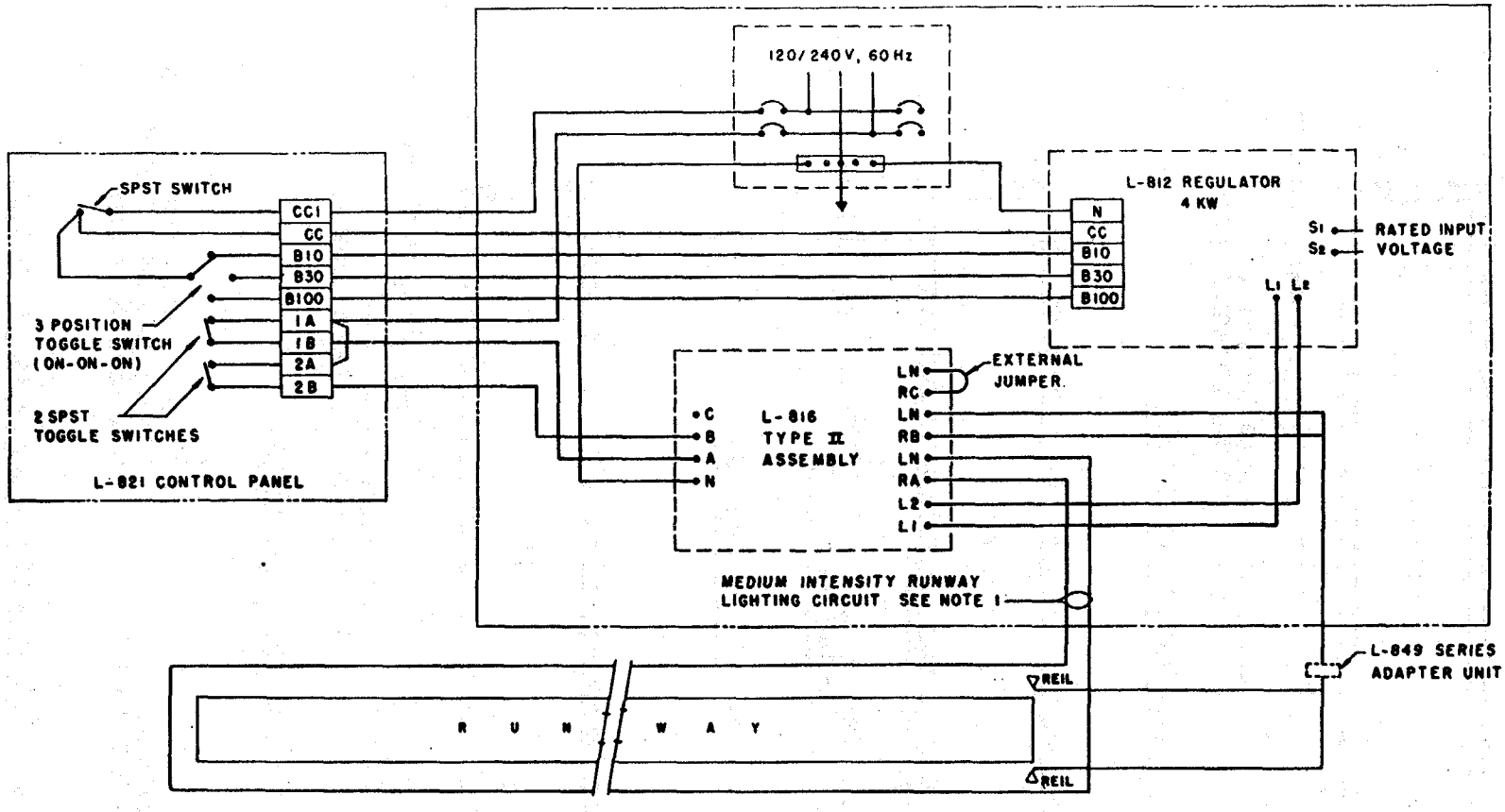
   (3). 1.62 OHMS/1000' X 4.16 AMPERES LOAD CURRENT = 6.74 VOLTS/1000'.

   (4). $\frac{12 \text{ VOLTS PERMISSIBLE VD}}{6.74 \text{ VD}/1000'} = 1780$ FEET

   (5). SINCE TWO WIRES ARE REQUIRED THE MAXIMUM DISTANCE IS $\frac{1780'}{2} =$ 890 FEET.

   (6). TO DETERMINE THE MAXIMUM DISTANCE USING OTHER WIRE SIZES, OBTAIN THE RESISTANCE OF THE WIRE PER 1000' AND FOLLOW THE ABOVE PROCEDURE.
9. THE CONTROL STATION MAY BE A REMOTE CONTROLLED SWITCH, RADIO CONTROL, OR AUTOMATIC CONTROL (PHOTOCELL OR TIMING DEVICES), OR CONTROL FROM RUNWAY EDGE LIGHTING CIRCUIT.

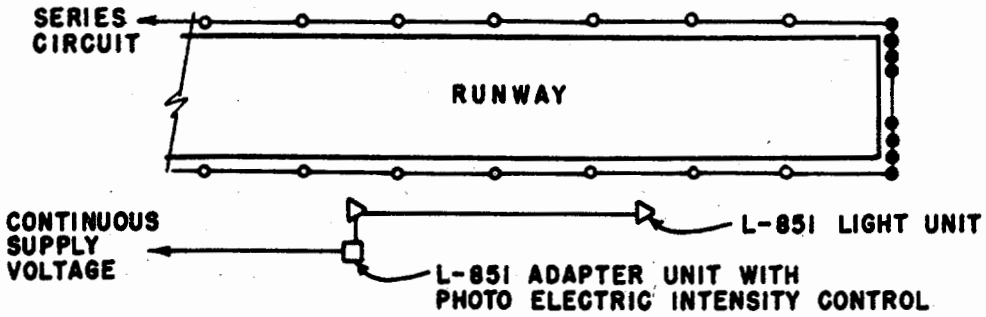
FIGURE 7. TYPICAL WIRING FOR REIL'S MULTIPLE OPERATION



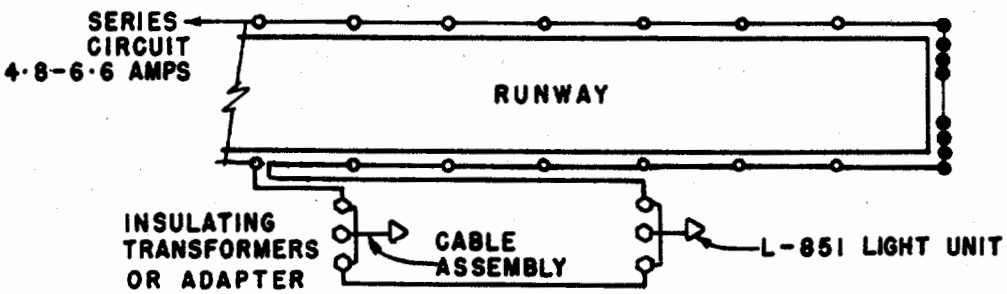
NOTES:

1. INSTALL MEDIUM INTENSITY FEEDER CABLES IN COMMON TRENCH WITH REIL FEEDER CABLES.
2. ADDITIONAL 1.3 KW LOAD WILL BE ADDED TO THE REGULATOR IF THE REILS UNITS ARE CONNECTED INTO THE RUNWAY LIGHTING CIRCUIT.
3. THE REILS UNITS ARE CONNECTED INTO THE ELECTRICAL CIRCUITS IN ACCORDANCE WITH THE EQUIPMENT MANUFACTURER'S RECOMMENDATIONS.

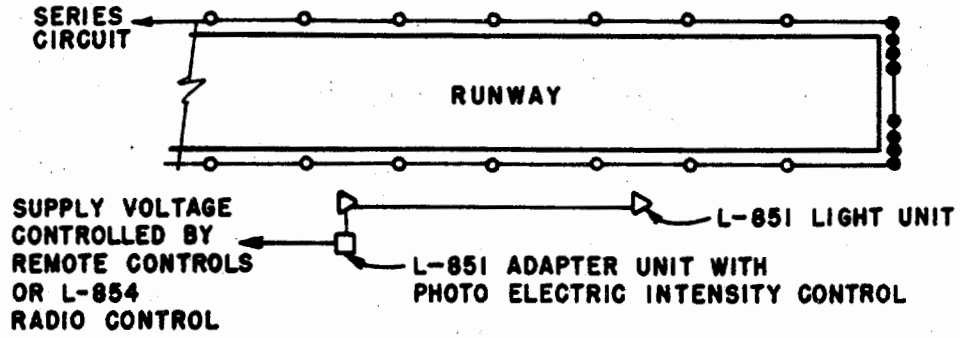
FIGURE 8. TYPICAL WIRING DIAGRAM FOR REIL'S SERIES OPERATION



CONTINUOUS OPERATION



SERIES OPERATION



MULTIPLE OPERATION

SYMBOLS

- ▷ L-851 LIGHT UNIT
- o RUNWAY EDGE LIGHT
- ● RUNWAY THRESHOLD LIGHT

NOTE:
PROVIDE CIRCUIT BREAKERS AND SWITCHES IN ACCORDANCE WITH LOCAL CODE REQUIREMENTS.

FIGURE 9. TYPICAL WIRING DIAGRAM FOR 2-BOX VASI

(a) Continuous Operation. Provide a continuous (2 kilowatt) source to permit the 2-box VASI to be energized at all times. Use a commercial photoelectric device to change the light intensity from a high to a low position for day and nighttime, respectively. Obtain the low setting by providing relays in conjunction with the photoelectric device to switch the input voltage to one half-rated value.

(b) Series Operation. Use insulating transformers in conjunction with the light unit to connect the 2-box VASI into the 4.8-6.6 ampere circuit. Do not connect the 2-box VASI in a circuit that has nominal intensity settings less than 4.8 amperes. The on-off operation and the brightness of the light units vary with the current in the series circuit. Select a series circuit capable of accepting an additional 2 kilowatt load for each 2-box VASI installation. Provide a selector switch as shown in Figure 9 to permit independent control of the 2-box VASI. At existing runway lighting installation, the 2-box VASI may be connected into the series runway lighting circuit; however, it would be necessary to burn the runway edge lights at top brightness if approach slope information is needed during daytime conditions.

(c) Multiple Operation. Use the light boxes with accessories provided for the specification to permit operation from a 2-kilowatt, 120-volt ± 6 volt, 60Hz source or a 240 volt $\pm$ 12 volt, 60 H_z source. Control the on-off operation of the light units with a remote switch or radio controls. Provide pilot relays with contacts rated to operate the 2-kilowatt load on a continuous basis.

(d) Wire Sizes. Use No. 8 AWG, 5-kilowatt wires to connect light units in series circuits. Make connections to multiple circuit with wire insulated for 600 volts minimum.

(2) Foundation. See paragraph 7f(2) for design details for the light unit's foundation.

6. EQUIPMENT AND MATERIAL.

a. Specifications and Standards.

(1) Equipment and material covered by specifications are referred to by specification numbers.

(2) Use distribution transformers, oil switches, cutouts, relays, terminal blocks, transfer relays, circuit breakers, photo-electric controls, and all other commercial items of electrical equipment not covered by Federal Aviation Administration specifications that conform to the applicable rulings and standards of the electrical industry.

b. Shelter. If power supplies and accessories are not designed for outdoor service, enclose it in the prefabricated metal housing, as described in AC 150/5340-9, or other outdoor enclosure conforming with industry standards.

c. Wires. Use No. 12 to No. 4 AWG wires in accordance with AC 150/5345-7. Use No. 19 AWG wires in accordance with REA Bulletin 345-14.

d. Concrete. Use concrete and reinforcing steel conforming with AC 150/5370-1A, Item P-610.

e. Radio Controls. Select radio controls in accordance with Appendix 1, Section 3.

f. Insulating Transformer. If control is provided from the runway lighting circuit, select an insulating transformer conforming with Handbook 6850.2 to obtain a sensing current from the series circuit.

g. MALSF.

(1) Steady Burning Lights. Select equipment in accordance with the requirements of Specification L-848. Order the number of light bars or light units needed for each installation. See paragraphs 7d(6) and 7d(7) for typical structural installation details. Obtain the lamps and frangible fitting from the supplier of the L-848 equipment. Obtain the 2.197-inch or 2.375-inch (outer diameter) vertical supports, rigid structures, and junction boxes from the installation contractor.

(2) Flashing Lights. Select equipment in accordance with the requirements of Specification L-849. Obtain the light units and accessories with provisions to attach to a 2.197-inch or 2.375-inch (outer diameter) vertical support from the L-849 equipment manufacturer. Use one L-849 master timer with each system (3 units) of sequenced flashing lights.

(3) Aiming Device. Obtain a device for aiming the L-848 and L-849 light units from the equipment manufacturer.

h. REIL.

(1) Light Unit. Select condenser discharge lights and accessories in accordance with the requirements of Specification L-849. Obtain L-849 fittings to permit the installation of the light unit on a 2.197-inch or 2.375-inch frangible vertical support. Obtain the vertical support from the installation contractor.

(2) Aiming Device. Obtain a device for aiming the REIL unit from the L-849 equipment manufacturer.

i. 2-Box VASI.

(1) Light Unit. Select light units in accordance with the requirements in Specification L-851. Those items not covered in Specification L-851 are provided by the installation contractor.

(2) Aiming Device. Obtain a device for aiming the VASI light unit from the L-851 equipment manufacturer.

7. INSTALLATION. Install the economy approach lighting aid in accordance with the latest revision of AC 150/5370-1A. Additional details are contained in the following paragraphs:

a. Wiring. Install underground cable in accordance with the requirements of AC 150/5370-1A, Item L-108. Make installations of wiring in vaults or prefabricated metal housing in accordance with AC 150/5370-1A, Item L-109.

b. Duct. Install underground electrical duct in accordance with the requirements of AC 150/5370-1A, Item L-110.

c. Equipment. Assemble the lighting equipment in accordance with the manufacturer's instructions.

d. MALSF.

(1) Approach Light Plane. Define the approach light plane as an imaginary plane. This plane passes through the beam center of the steady-burning lights in the system. The plane is rectangular in shape, 400 feet wide, and centered on the MALS centerline. It originates at the landing threshold and extends 200 feet beyond the last light bar at the approach end of the MALSF. Due to the requirement for elevated lights in station 2 + 00, consider these lights at runway elevation even though they project several inches above it. If a single horizontal light plane is not possible, raise or lower it within the limits of paragraph 7d(5).

(2) Clearance. Permit no objects above the approach light plane. For approach light plane clearance purposes, consider all roads, highways, vehicle parking areas, and railroads as vertical solid objects. Make the clearance required above interstate highways 17 feet, for railroads 25 feet, and for all other roads, highways, and vehicle parking areas 15 feet. Measure the clearance for roads and highways from the crown of the road and make measurements for railroads from the top of rails. Make measurements for vehicle parking areas clearances from the average grade in the vicinity of the highest point. Airport service roads, where vehicular traffic is controlled in any manner which would preclude blocking the view of the approach lights to landing aircraft, are not considered as obstructions in determining the approach light plane.

(3) Location and Orientation. Install all light bars perpendicular to the vertical plane containing the MALSF centerline.

(4) Visibility. Provide a clear line of sight to all lights of the system from any point on a surface, 1/2-degree below a 3-degree glide path, intersecting the runway 1,000 feet from the landing threshold. This line of sight applies to 250 feet each side of the entire length of the MALSF and extends up to 1,600 feet in advance of the outermost light in the system. See Figure 10 for details.

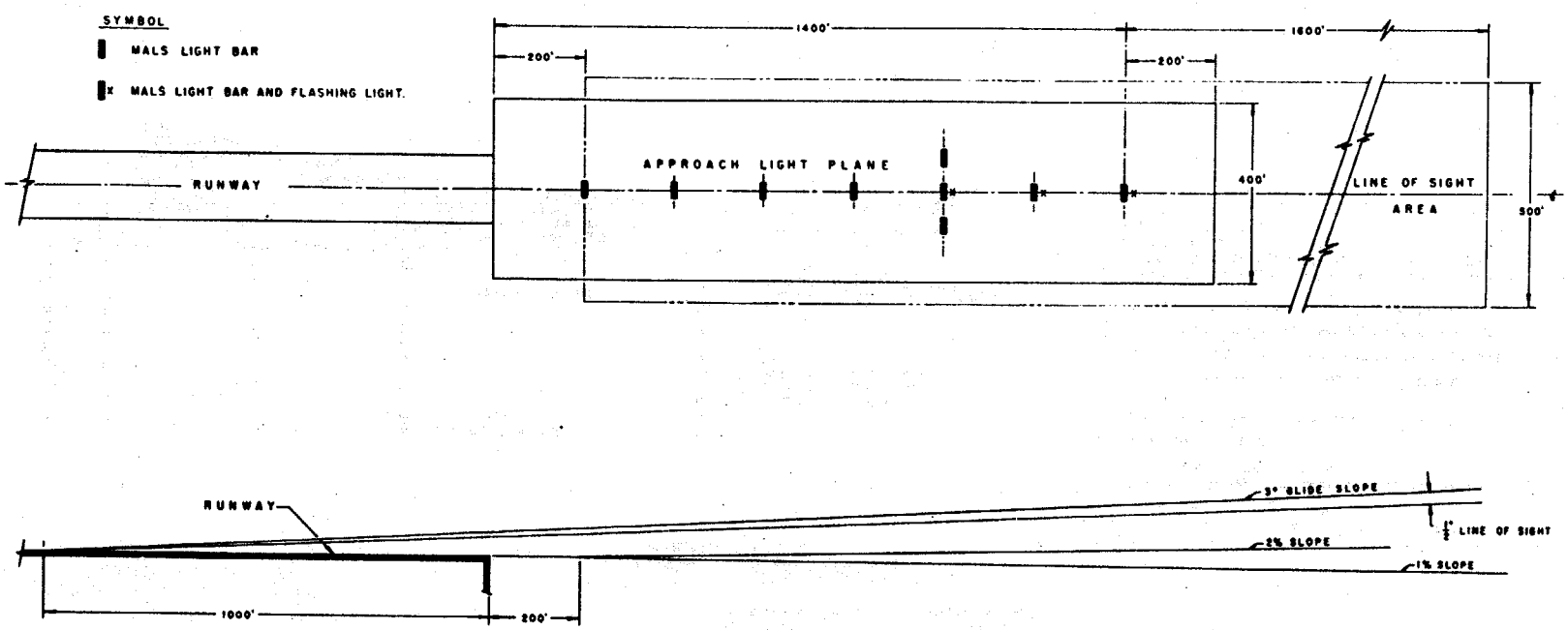
(5) Slope Gradient.

(a) Keep the slope gradient as small as possible and do not exceed 2 percent for a positive slope or 1 percent for a negative slope. Start the sloping segment no closer than 200 feet from the landing threshold. Provide at least three consecutive light bar stations (400 feet) in a sloping segment. Permit only one positive sloping segment in the system. Start the sloping segment at the first light bar and extend it to the end of the system. If required, precede the sloping segment with a horizontal segment or follow it with either a horizontal or negative sloping segment.

(6) Frangible Structures. Install frangible MALS structures as shown in Figure 11.

(7) Rigid Structures. Install rigid MALSF structures as shown in Figure 12.

(8) Equipment. Assemble the lighting equipment in accordance with the manufacturer's instructions.



NOTES:

1. THE APPROACH LIGHT PLANE IS AN IMAGINARY PLANE WHICH PASSES THROUGH THE BEAM CENTER OF ALL STEADY BURNING LIGHTS IN THE SYSTEM. THE PLANE IS RECTANGULAR IN SHAPE 400 FEET WIDE (CENTERED ON THE MALS CENTERLINE), ORIGINATING AT THE LANDING THRESHOLD AND EXTENDING 200 FEET BEYOND THE LAST STEADY BURNING LIGHT BAR (AT APPROACH END OF SYSTEM).
2. KEEP SLOPE GRADIENT AS SMALL AS POSSIBLE AND START IT NO CLOSER THAN 200 FEET FROM THE LANDING THRESHOLD.
3. PROVIDE A CLEAR LINE OF SIGHT TO ALL LIGHTS OF THE SYSTEM FROM ANY POINT ON A SURFACE, ¼ DEGREE BELOW THE GLIDE PATH AND EXTENDING 250 FEET EACH SIDE OF THE CENTERLINE. THIS REQUIREMENT APPLIES TO THE ENTIRE MALS AND 1600 FEET IN ADVANCE OF THE OUTERMOST LIGHT IN THE SYSTEM.

FIGURE 10. APPROACH LIGHT PLANE AND LINE OF SIGHT

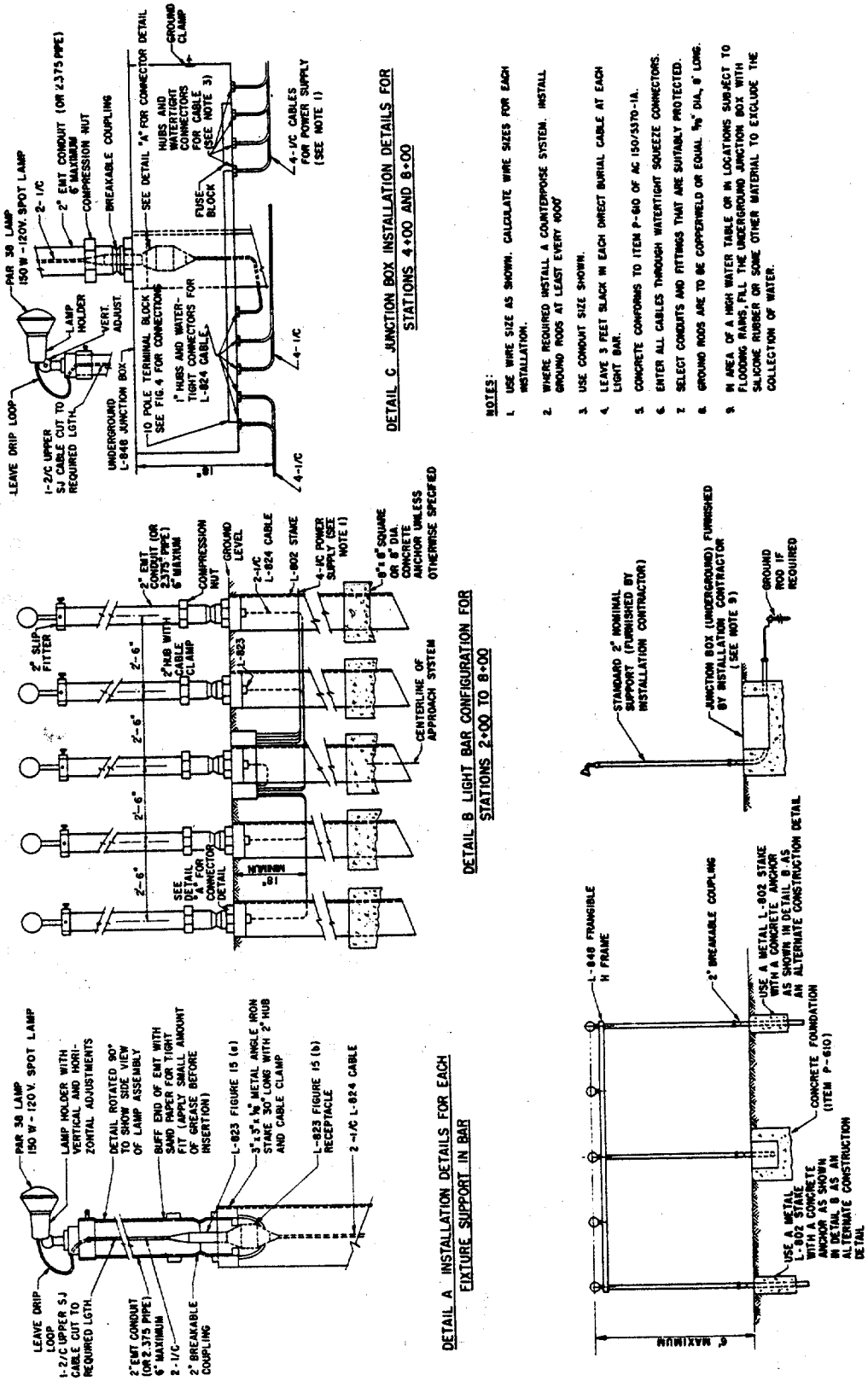
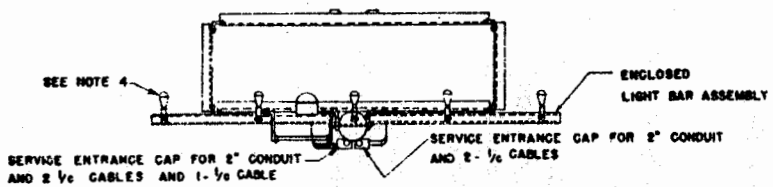


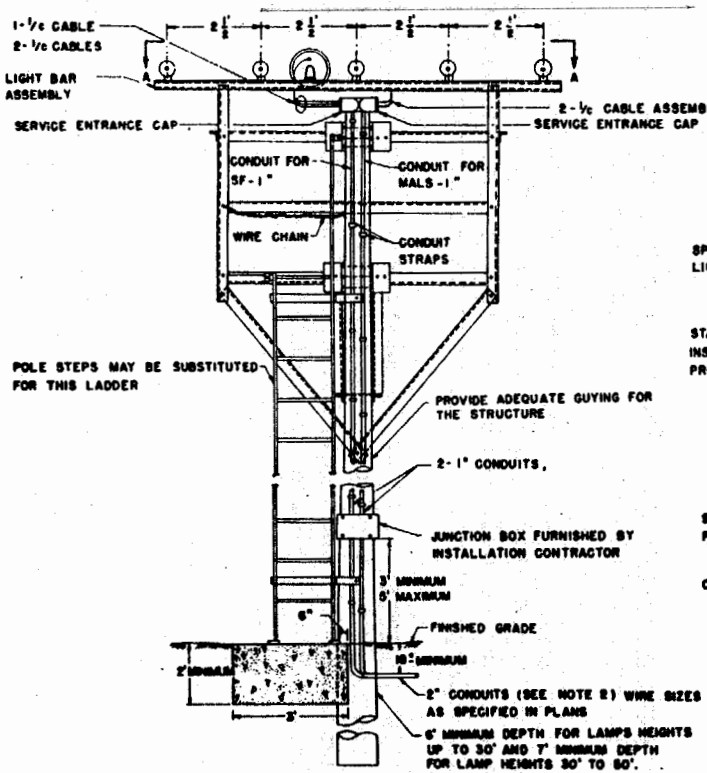
FIGURE 11. TYPICAL INSTALLATION DETAILS FOR FRANGIBLE MALS STRUCTURES - 6-FOOT MAXIMUM



VIEW A-A

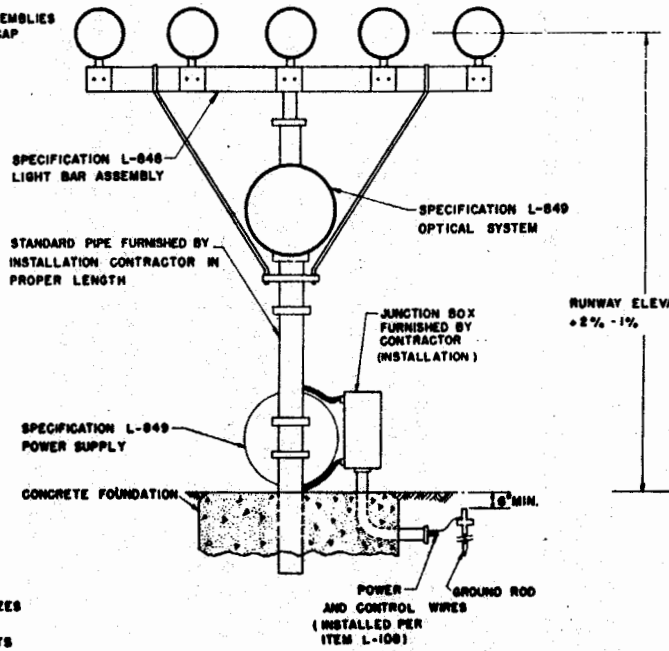
NOTES

1. Use wire type as shown. Wire size for power supply must be calculated for each installation.
2. Use conduit size shown. If size is not specified, use the number of wires to be enclosed as the basis for determining minimum conduit size.
3. Use galvanized steel conduit and fittings. Attach conduits firmly to pole with conduit straps.
4. The structure shown in view A may be used for semifrangible installations providing the lights are mounted on 6 foot frangible supports.



VIEW A - STRUCTURE

RIGID 20' TO 50'



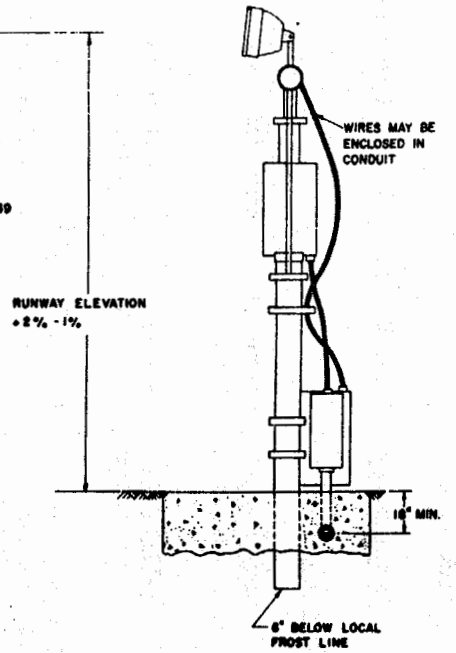


FIGURE 12. TYPICAL INSTALLATION DETAILS FOR SEMI-FRANGIBLE AND RIGID MALS STRUCTURES

e. REIL.

(1) Location. Locate the REIL units and aim them as shown in Figure 2.

(2) Structures. See Figure 13 for typical installation details.

f. 2-Box VASI.

(1) Location. Locate the 2-box VASI and aim the light units as shown in Figure 3.

(2) Structures. Install light units on supports and concrete foundations as shown in Figure 14.

g. Alternate Installation Details. Use details contained in FAA Handbooks 6850.2 and 6850.3 for guidance to obtain alternate methods of installing economy approach lighting aids.

8. INSPECTION.

a. Light Unit. Inspect each light unit to determine that the equipment has been installed at the proper location, height, and with the proper light fixture orientation and aiming.

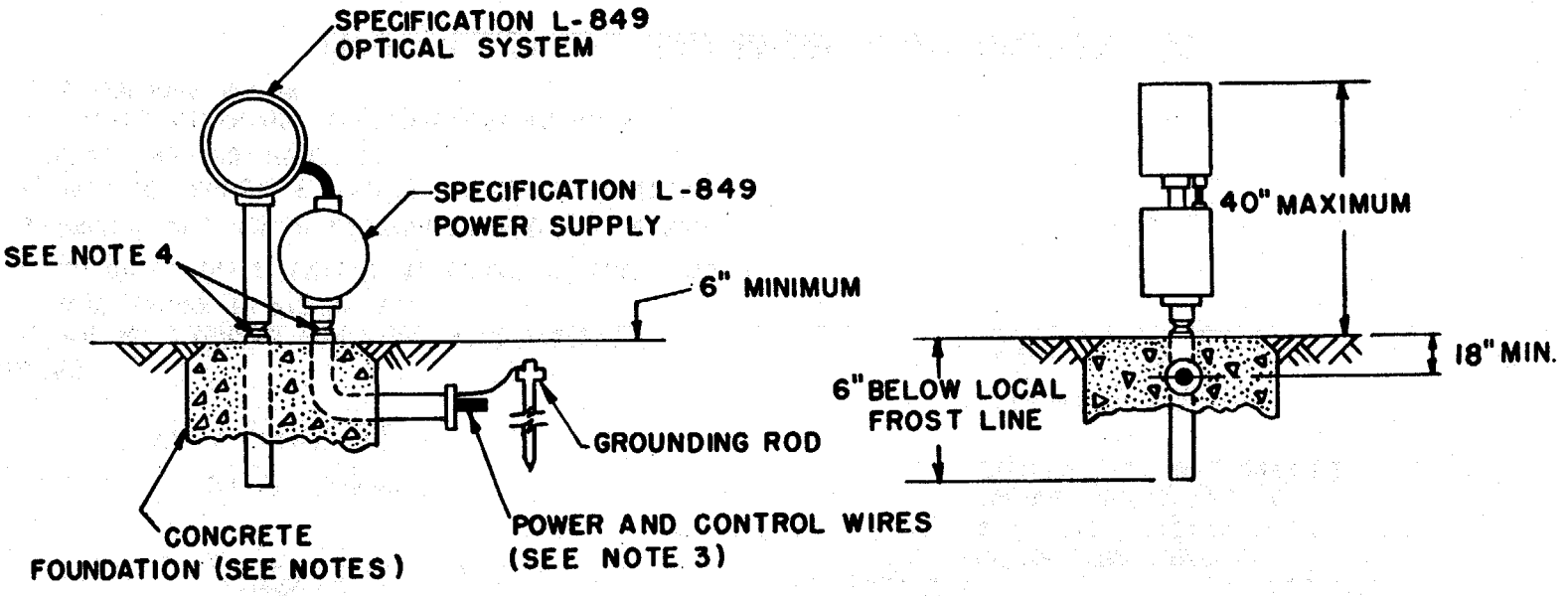
b. Wiring and Components. Check all wiring and electrical components (fuses, circuit breakers, transformers, switches, etc.) to determine that ratings are correct and the components are installed in accordance with local electrical code requirements.

c. Lamps. Check the voltage at the lamps to determine if the supply voltage is within specified tolerance. If a voltage in excess of rated voltage is impressed across a lamp, the life of the lamp will be reduced.

d. Securing Hardware. Check all nuts, bolts, and other hardware to determine if the components are secure.

e. Installation. Check the systems' environment to determine conformance with installation requirements. Check the systems' equipment to determine that it has been assembled and placed in accordance with the equipment manufacturer's instructions.

e. Flight Check. Before commissioning, make provisions to have economy approach lighting aids flight checked to insure that the systems meet the requirements of Handbook OA P 8200.1, United States Flight Inspection Manual.



TYPICAL RUNWAY END INDENTIFIER LIGHT UNIT INSTALLATION

NOTES

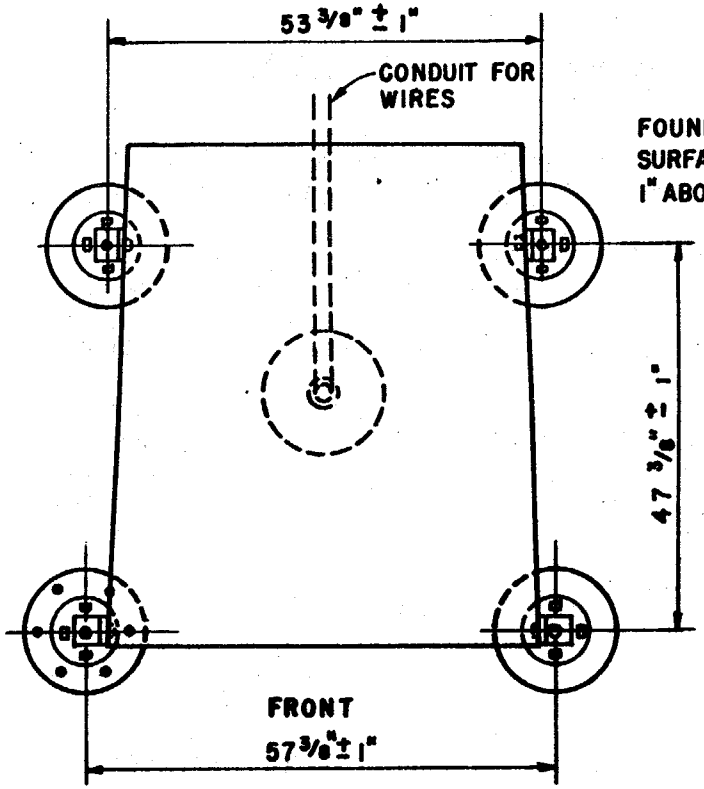
1. THE INSTALLATIONS CONFORM TO THE APPLICABLE SECTIONS OF THE NATIONAL ELECTRICAL CODE AND LOCAL CODES.

2. THE SIZE OF THE CONCRETE FOUNDATION IS AS INDICATED ON THE PLANS.

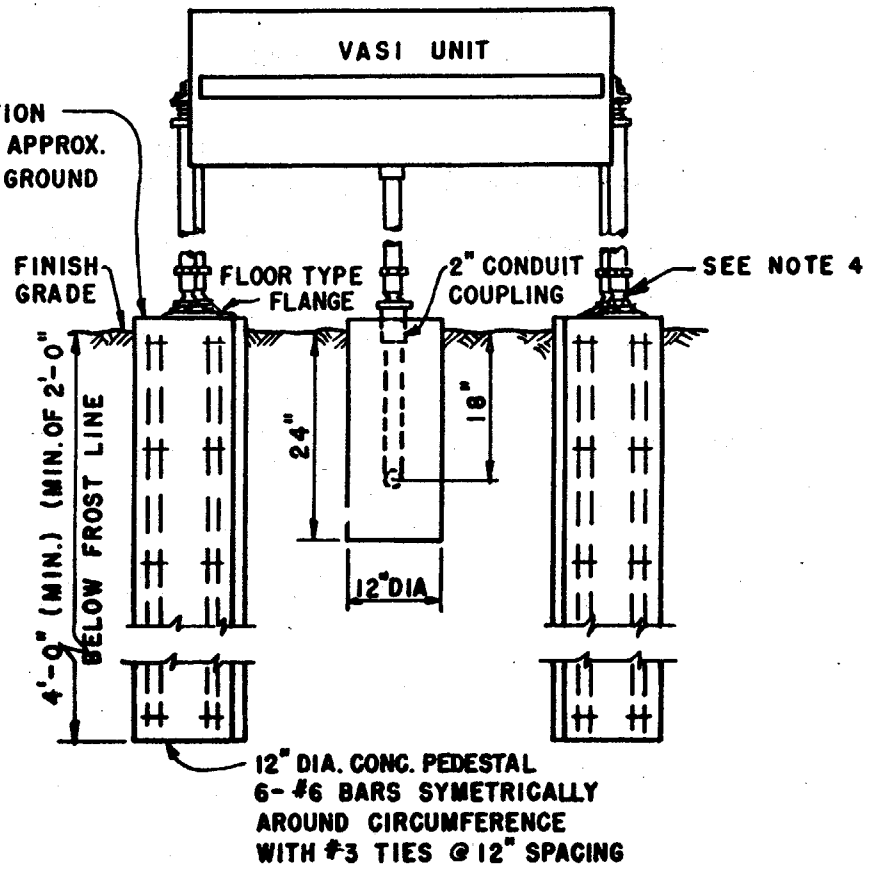
3. THE INSTALLATION OF POWER AND CONTROL WIRES IS IN ACCORDANCE WITH THE APPLICABLE SECTIONS OF ITEM L-108 OF STANDARD SPECIFICATIONS FOR CONSTRUCTION OF AIRPORTS.

4. PROVIDE FRANGIBLE SUPPORTS FOR THE LIGHT UNIT AND POWER SUPPLY. THE OUTSIDE DIAMETER OF THE SUPPORTS CAN BE 2.197-INCHES, OR 2.375-INCHES.

FIGURE 13. TYPICAL INSTALLATION DETAILS FOR RUNWAY END IDENTIFIER LIGHTS



PLAN VIEW
VASI LIGHT UNIT



FRONT ELEVATION
VASI LIGHT UNIT

NOTES:

1. WIRING DIAGRAMS FOR 2-BOX VASI SYSTEMS ARE SHOWN IN FIGURE 9.
2. CONDUITS SHALL EXTEND AT LEAST 18" BELOW GRADE.
3. GROUND ALL POWER ASSEMBLIES AND VASI BOXES.
4. PROVIDE FRANGIBLE MOUNTS FOR ALL SUPPORTING LEGS AND INPUT POWER LEG.
5. UNLESS OTHERWISE SPECIFIED, USE MOUNTING DIMENSIONS SHOWN.

FIGURE 14. TYPICAL INSTALLATION DETAILS FOR 2-BOX VASI

9. TESTS.

a. Operational. Operate each system not less than 1/2 hour. In addition, operate each control not less than 10 times.

b. Primary Cables. Test the circuit cables in accordance with the applicable sections of AC 150/5370-1A, Item L-108.

10. MAINTENANCE.

a. Preventive. Establish a preventive maintenance program at airports with MALSF, REIL, or 2-Box VASI to insure proper equipment operation and reliable service. The preventive maintenance program should be acceptable to the FAA. An improperly maintained system may cause equipment failure, a false signal, or rapid deterioration of the system's effectiveness.

b. Lamps. Make a daily operational check of all economy approach lighting aid fixtures to locate and replace burned-out lamps. Adequate spare lamps should be available to permit a complete replacement of all lamps in the system. The rated life of the lamp can be used to estimate interval between lamp replacements.

c. Cleaning. Clean the optical system of economy approach lighting aids to permit light units to operate at maximum efficiency.

d. MALSF and REIL.

(1) Check all control equipment daily for proper operation.

(2) Make weekly inspection of mechanical parts for cleanliness and for structural defects such as chipping, cracking, or bending.

(3) Make monthly checks of the aiming of the steady burning and flashing lights. Use the aiming device furnished with the system.

(4) Make semiannual voltage checks to determine if input voltages are within design limits.

(5) Check electrical parts annually for cracking, corrosion, or shorting. Replace parts having such defects.

(6) Periodically remove growth in the vicinity of the equipment that might interfer with proper operation of the lighting system.

(7) Make additional periodic inspections and checks recommended by the equipment manufacturer.

e. Two-Box VASI.

(1) Daily Checks

(a) Make daily checks of lamps and the aiming of the initial VASI installation to insure stabilization of the system. After stabilization is assured, the aiming of the light units should be checked weekly. The aiming device furnished by the equipment manufacturer or a transit can be used for these checks. Keep a record of all angular settings made to the VASI system together with dates such settings were made.

(b) Check all control equipment for proper operation.

(2) Weekly Checks. Make inspections of mechanical parts for cleanliness and structural defects such as chipping, cracking, or bending.

(3) Semiannual Checks. Make voltage checks to determine if input voltages are within design limits.

(4) Annual Checks. Check electrical parts for cracking, corrosion, or shorting. Replace parts having such defects.

(5) Unscheduled Checks.

(a) Remove growth in the vicinity of the equipment that might interfere with proper operation of the lighting system.

(b) If the light units are accidentally or purposely removed from the mounting legs, the reinstalled system should be flight checked.

(c) Make additional periodic inspections and checks recommended by the equipment manufacturer.

(6) Leveling Device Checks. The leveling device is a precision instrument, factory calibrated with a laboratory standard and should be handled and stored with care to retain its accuracy. With careful handling, it is unlikely that the instrument will be out of adjustment; however, the device can be checked for accuracy by the following method.

(a) Select an unwarped table or bench and level it with a carpenter's level.

(b) Set the level dial to 0^{o}.

(c) With equal size blocks inserted under the channel of the level bar near each end, the bubble should appear very near (or at) the center of the level tube.

(d) Rotate the level 180^{o} and repeat the procedure in (c) above. The bubble should appear at the same relative position in the level tube if the bench is level.

(e) If the bubble is not centered within two divisions on the level tube (each division is 1.2 minutes) recalibrate by adjusting the level tube until the bubble appears centered with the level dial at 0^{o}. Repeat steps (c), (d), and (e) until the bubble remains centered in each step.

(7) Lamp Life. Tests indicate that prefocused, quartz-iodine lamps will operate satisfactorily for approximately 2,000 hours with approximately 16 percent having blackened with filaments still burning. On the basis of these tests, a group replacement of all lamps at the end of 2,000 hours burning at top brightness is recommended. Good lamps removed at this time can be used for interim replacements for those that blacken or fail.

SECTION 1. SPECIFICATION FOR L-848 MEDIUM INTENSITY APPROACH LIGHTING EQUIPMENT

1. PURPOSE. This specification contains the requirements for medium intensity lighting equipment.

2. REFERENCES. The applicable specifications (see Appendix 3) of the issue in effect on the date of application for qualification apply to this specification. In case of conflict, this specification governs.

3. SCOPE OF SPECIFICATION. The specification requirements are for a horizontal approach light bar with 5 lamps. Provisions are made for attaching the light bar to vertical supports.

4. MATERIAL AND WORKMANSHIP. Use components and materials of industrial quality or better. Workmanship must be in accordance with high-grade commercial practice.

5. PERFORMANCE REQUIREMENTS.

   a. Current Rating. Provide all current carrying parts with ratings suitable for continuous operation of the lighting load.

   b. Environmental Conditions. Design and construct the unit for continuous service under the following conditions.

      (1) Temperature. Any ambient temperature from a minimum of -55 degrees Centigrade to a maximum of +55 degrees Centigrade at sea level.

      (2) Weather. Continuous outdoor operation under normal weather conditions, including wind velocities up to 100 miles per hour, sand, dust, and salt spray.

6. DETAIL REQUIREMENTS.

   a. Mounting Bar Assembly. Fabricate the horizontal mounting bar assembly and all metal parts from nonferrous metal suitable for use as an approach light bar. Cadmium, nickle, or zinc coat all copper bearing hardware in contact with aluminum.

      (1) Fabrication. Provide a mounting bar having a total length of 10 feet $\frac{+4}{-0}$ inches with means for mounting 5 lampholders (paragraph 6d) at equal spacing of 2-1/2 feet center-to-center distance between each lampholder. The shape of the bar is optional

providing the flexural and torsional strength equals or exceeds that of standard aluminum pipe with a 2.375-inch outer diameter. The total length of the mounting bar may be obtained by the use of pipe, pipe sections, and pipe fittings or other shapes of nonferrous metal construction that can meet the requirements of paragraph 5. Design the bar of adequate strength to support its own weight and an additional 30-pound load of the L-849 sequence flasher light unit.

(2) Attachments. When specified, supply the mounting bar with one of the following attachments.

(a) "T" Frame Mounting. Provide a removable fitting in the center of the mounting bar to rigidly secure the horizontal mounting bar to a 2.375-inch or 2.197-inch outer diameter vertical pipe support supplied by others. Also provide means for supporting the horizontal mounting bar, when installed on the vertical mounting pipe, to assure rigidity and strength. Diagonal supports are acceptable.

(b) "H" Frame Mounting. Provide a removable fitting in the center of the bar and one removable fitting at each end of the bar assembly for mounting on a 2.375-inch or 2.197-inch outer diameter vertical pipe support.

(3) Factory Wiring.

(a) "T" Frame Mounting. Factory wire the lampholders and the horizontal bar mounting for field installation on a 2.375-inch or 2.197-inch outer diameter vertical pipe support supplied by others. Neatly run and fasten with clips or other means, all wires so that they will be mechanically secured and be adequately protected from abrasion. Make all wire connections within the bar assembly accessible to provide easy maintenance, removal and/or replacement of component parts and wires. Provide 12 feet of additional wire from the center of the mounting bar assembly for connection to incoming power leads.

(b) "H" Frame Mounting. Factory wire the lampholders and the horizontal bar mounting as specified in the preceding paragraph (a). Provide 12 feet additional wire from the center of the mounting bar assembly for connection to the incoming power leads.

(c) Wire. Use not less than No. 14 AWG stranded weatherproof wire of the highest commercial quality suitable for wiring the assemblies and for application in the installations shown in Figures 11 and 12.

b. Lampholder Mounting Assembly. Provide an adjustable PAR 38 lampholder assembly and fitting with provisions to securely attach the lampholder to a 2.375-inch or 2.197-inch outer diameter vertical pipe support. Design the assembled unit to meet the requirements of paragraph 5b(2). Select lampholders to meet the requirements of paragraph 6d.

c. Lamps. Provide five PAR 38 spotlights, each rated at 150 watts with a rated life of 2,000 hours at 120 volts.

d. Lampholder. Fabricate all metal parts of the lampholder from nonferrous metal or other suitable material. Provide,on the mounting hardware of the lampholder,a means for vertical adjustment of the light beam from -5 to +15 degrees and a zero degree horizontal reference point. Cadmium, nickle, or zinc coat all copper bearing hardware in contact with aluminum.

(1) Drain Hole. Make provision in the lampholder to drain off any accumulation of water due to condensation.

(2) Mounting.

(a) Bar Assembly. Provide a threaded swivel stem mounting for mounting the lampholder on the horizontal mounting bar.

(b) Lampholder Assembly. Provide a threaded stem mounting attached to a fitting for mounting the lampholder on a 2.375-inch or 2.197-inch vertical pipe support.

(3) Weatherproof Seal. Provide means in the lampholder to obtain a weatherproof seal for the PAR 38 lamp when in place. Use weatherproof seal material that will withstand the maximum contact temperature of the lamp.

e. Aiming Device. Provide a suitable vertical aiming device graduated in one degree increments which will permit the aiming of each lampholder and/or the entire lamp bar at any vertical angles from -5 to +15 degrees. Furnish one aiming device for each MALS installation.

f. Painting. Paint all exposed surfaces of the lampholders; horizontal bar assembly; all supports for rigidity and strength; and all fittings with a suitable prime coat, body coat, and finish coat. Use enamel paint equal to Federal Specification TT-E-489 as the finish coat. Color should be in accordance with Federal Standard 595, Aviation Orange, No. 12197.

g. Parts List and Installation Instructions. Furnish a parts list and installation instructions with each installation. Submit sufficient drawings or illustrations to clearly indicate the method of installation.

h. Breakable Coupling. Supply a breakable coupling, as determined in the test specified in paragraph 7a(3), for installation in each vertical pipe support of each bar assembly which is to be frangible mounted.

i. Method for Attaching 2-Inch Conduit to Breakable Coupling. Supply a compression nut, a slip fitter, or other means, as determined by tests specified in paragraph 7a(3), for attaching the vertical pipe support to the breakable coupling of each bar assembly which is mounted on a frangible support.

7. TESTING.

a. Approval Testing. Each manufacturer must submit full data showing that a sample unit completely assembled and wired has successfully passed the following tests.

(1) Operation. Connect a completely assembled and wired approach light bar, with lamps installed, to a 120-volt, 60 Hz power supply and check for proper operation.

(2) Dielectric. Check all wiring of the approach light bar, with lamps removed, by applying a potential of at least 1,500 volts AC, 60 HZ for a period of one minute between each conductor and the metal assembly. No breakdown of insulation is allowed.

(3) Weather. Submit certified test data that the bar assembly (installed on three, 6-foot vertical pipe supports of 2.375-inch or 2.197-inch outer diameter) and the compression nut (or other means of attaching the vertical supports to the breakable coupling) meet the requirements specified in paragraph 5b(2).

b. Inspection. The Federal Aviation Administration, Airports Service, Washington, D.C. 20590, will make additional inspections and tests as deemed necessary to determine compliance with the specification.

8. QUALIFICATION. See Appendix 1, Section 4, for qualification requirements.

SECTION 2. SPECIFICATION FOR L-849 CONDENSER DISCHARGE TYPE FLASHING LIGHT

1. PURPOSE. This specification contains the requirements for condenser discharge light units and their accessories.

2. REFERENCES. The applicable specifications (see Appendix 3) of the issue in effect on the date of application for qualification apply to this specification. In case of conflict, this specification governs.

3. MATERIAL AND WORKMANSHIP. Select components and materials of industrial quality or better. Use workmanship in accordance with high grade commercial practice.

4. TYPES, STYLES, AND ADAPTER.

   a. Manufacture the light in two types as follows:

      (1) Type III - Multiple unit for operation with a 120 volt primary input.

      (2) Type IV - Multiple unit for operation with a 240 volt primary input.

   b. Make the light units in either of two styles as follows:

      (1) Style "A" - with provisions for mounting on a vertical 2.375-inch or 2.197-inch outer diameter pipe.

      (2) Style "B" - with provisions for attaching to the Specification L-848 light bar.

   c. Provide an adapter rated for 5 kilovolts to permit the operation of the Type III or Type IV unit in a series circuit with a variable 2.8 - 6.6 amperes.

5. PERFORMANCE REQUIREMENTS.

   a. Design the condenser discharge type lights to provide the light distribution specified in paragraph 6b(4).

   b. Design and construct the lights for continuous outdoor operation under all conditions including:

      (1) Temperature. Any ambient temperature from a minimum of -55°C to a maximum of 55°C at sea level.

(2) Salt Spray. Exposure to salt laden atmosphere.

(3) Altitude. Any altitude from sea level to 10,000 feet above sea level.

(4) Wind. Wind velocities up to 100 miles per hour.

(5) Humidity. A relative humidity range from 10 percent to 100 percent.

6. DESIGN REQUIREMENTS.

a. General. Provide the same basic optical system and power supply for the REILS and SF light units. Provide the capability of separating optical system and power supply in two separate housings.

b. Optical System. Provide an optical system consisting essentially of a housing containing a flash lamp and reflector or a PAR 56 flash lamp. Assemble the components to form a unit capable of meeting all requirements specified in paragraph 5.

(1) Flash Lamp. Select a commercially available flash lamp with a minimum operating life of 500 hours, or 3,600,000 flashes.

(2) Housing. Use aluminum or other suitable metal to house the optical system. Protect all metal parts to prevent corrosion and paint exterior surfaces as specified in paragraph 6f. Use compatible materials to prevent electrolytic action. Secure the rear section of the housing or cover to the main body with noncorrosive bolts. Supply a suitable gasket between the two sections to obtain a raintight seal. Provide drain holes, louvers, or screened vents for breathing, as required. Make provisions for grounding the housing. Keep the weight of the housing with components in place less than 30 pounds.

(3) Cover Glass. If required, select the glass of the highest commercial quality for this type of application that will meet the requirements of paragraph 5. PAR-type lamps must be exposed to surrounding ambient temperatures to prevent over heating of the lamp; therefore, a cover glass should not be used with this type lamp.

(4) Photometric Requirements.

(a) Design the condenser discharge light to produce a beam axis intensity of not less than 10,000 and not more than 17,000 effective candelas at rated input voltage. Make provisions for the light output at 12-1/2 degrees from the beam axis and at any point within the cone so formed to be not less than 5,000 effective candelas.

(b) Make the flash duration not less than 90 microseconds, nor more than 150 microseconds at 50 percent of the beam axis (0°) intensity. Measure the duration of the flash between points on the rise and decay curve where the intensity is 50 percent of maximum in the direction of measurement.

(5) Cable Entrance. Pass all cables entering or leaving the optical system housing through squeeze raintight connectors, except those cables entering or leaving the housing through conduit or frangible coupling.

(6) Mounting. Design the Style "A" units to attach to a 2.375-inch or 2.197-inch outer diameter vertical pipe. Design the Style "B" units to attach to a Specification L-848 light bar. If required, provide a breakable coupling capable of supporting the 30-pound light unit on a 2-inch vertical support 40 inches high in a 100-mile per hour wind.

(7) Aiming. Design the optical system of the light unit so it can be aimed from 0 to +15 degrees in a vertical plane. Provide a positive locking device adequate to prevent accidental movement of the light. Provide an aiming device with the REILS and SF to permit vertical setting of the optical system of the flashing lights from 0 degrees to +15 degrees. Graduate the scale on the aiming device in not more than one degree increments. Make provision for aiming the REILS in a horizontal plane from 0 to 15 degrees either side of the center of the fixture.

c. Power Supply. Provide a power supply that consists essentially of a housing containing the input transformer, flash condenser, rectifier, resistors, terminal blocks, fuses, and other necessary components. Design the power supply to weigh not more than 60 pounds and meet all requirements of paragraph 5b.

(1) Housing. Use aluminum or other suitable material for housing the power supply. Protect the metals to prevent corrosion, and paint exterior surfaces as specified in paragraph 6f. Use noncorrosive hardware to secure the cover of the housing in place. Provide gasketing between the housing and cover to obtain a raintight seal. Provide drain holes, louvers, or screened vents for breathing, as required. Make provisions for grounding the housing. Use compatible materials to prevent electrolytic action.

(2) Cable Entrances. Pass all cables entering or leaving the power supply through squeeze raintight connectors, except those cables entering or leaving the housing through conduit or a frangible coupling.

(3) Input Transformers.

(a) Type III Unit. Design the transformer to furnish adequate power to the equipment with an input voltage of 120 volts AC ±6 volts.

(b) Type IV Unit. Design the transformer to furnish adequate power to the equipment with an input voltage of 240 volts AC ±12 volts.

(4) Flash Condenser. Select a condenser with the capacitance and an operating voltage level to produce an energy level to permit the optical system to meet the photometric requirements of paragraph 6b(4). Select a condenser with a design rating adequate for condenser discharge application. Use a condenser rated to perform at the temperature limits specified in paragraph 5b(1).

(5) Electron Tubes and Solid State Device. Use components of high grade industrial quality.

(6) Trigger Relay. Provide a removable trigger relay or device. Design the components to permit maintenance with minimum downtime. Select the relay or device with contacts that have an adequate rating for the service intended.

(7) Terminal Block. Provide a terminal block for all wires entering or leaving the power supply housing. Select a terminal block of rugged construction with noncorrosive pressure type terminals of the correct current carrying capacity and voltage rating.

(8) REILS Master Timer. Use a reliable timing device installed in the power section of one of the pair of light units or in adapter unit. Select a device to flash both units simultaneously at the rate of two flashes per second. Make the design and construction of the timer and its component parts suitable for operation under all environmental conditions specified in paragraph 5b.

(9) Components. Select all resistors, condensers, and other components to operate within the manufacturer's suggested rating under all environmental conditions specified in paragraph 5b. Arrange the components in the power supply to simplify maintenance. Provide an optical baffle per Appendix 1, Section 2, Figure 1.

(10) Grounding Lug. Provide a grounding lug on the outside of the power supply. Select a lug adequate for a No. 6 AWG wire.

d. MALSF Master Timer.

(1) Provide a master timer housing with a weatherproof construction. Make the housing of sturdy construction and design it to hold its shape under normal methods of shipment, installation, and field maintenance. Protect the metal used for the housing to permit continuous outdoor use under all environmental conditions specified in paragraph 5b. Use noncorrosive metal for securing parts. Paint the exterior of the housing as specified in paragraph 6f.

(2) Provide a master timer capable of operating eight or less condenser discharge lamps in sequence. Provide for the total of the flash duration plus the dark interval between adjacent units at 1/30 second $\pm$1/120 second. Repeat the sequence at a regular rate of 120 $\pm$ 2 flashes per minute.

(3) Energize the trigger circuit of each condenser discharge unit from the master timer. Design the system for reliable and satisfactory operation over a distance of 5,000 feet of No. 19 (minimum) AWG wire. The control wires are not a part of this specification.

(4) Design the master timer to operate properly with the light units. If an external source voltage is required for proper operation, design the unit for a 120 volt, 60 Hz input. If internal source voltages are used, select values that will permit proper operation over at least the distance specified in paragraph (3) above.

(5) Design and construct the master timer components to have a minimum operating life of 5,000 hours.

(6) Provide an area sufficient for the entry of the timing and power conductors in the bottom or side of the master timer housing.

e. Interlock Switches.

(1) Incorporate cover operated interlock switches in both the optical system and power supply housings. Connect these switches so that upon the opening of either cover, the following will occur.

(a) Provide protection to prevent accidental contact with high voltage.

(b) Discharge of the flash condenser to a maximum of 50 volts within 60 seconds is through a suitable resistor network.

(2) Design the circuit with a bleeder resistor permanently connected to discharge the flash condenser in case the interlock switches fail to operate. Provide for the bleeder resistors to reduce the condenser voltage to a maximum of 50 volts within 60 seconds.

f. Painting. Protect the exterior of the power supply housing, light unit housing, MALS master timer housing, and unprotected mounting items with not less than a primer coat, a body coat, and a finish coat of paint. Make the final paint aviation surface orange color, baked enamel finish with the paint meeting the requirements of Federal Specification TT-E-489. Use aviation gloss orange color No. 12197, Federal Standard No. 595. Make the final painted surface free of blotches, scratches, runs, etc.

g. Warning Sign. Stencil on the cover or covers of the condenser discharge units the following: "Danger, High Voltage - Deenergize Flasher Power Circuit Before Removing Cover." Place a conspicuous warning sign within the power supply housing which reads: "Caution, Short or Ground All High Voltage Terminals." Place a permanent type stencil or sign on the light unit which reads: "Danger, High Voltage - Deenergize Flasher Circuit Before Removing Cover."

h. Nameplate.

(1) Attach to the outside of the light unit power supply a nameplate, permanently and legibly filled in with at least the following information:

(a) Condenser Discharge Type Light.

(b) Type.

(c) Identification: FAA-L-849.

(d) Rating: _____ Volts, _____ Amperes, Single Phase, 60 Hz.

(e) Manufacturer's Part No. _____.

(2) Provide a nameplate for the Runway End Identifier Unit with the above information and an indication as to which unit contains the master timer.

i. Parts List and Instruction Book. Provide a complete parts list and installation instructions with each new installation. Furnish the parts list and installation instructions with individual assemblies shipped for maintenance or replacement purposes. Furnish sufficient drawings or illustrations to indicate clearly the method of assembly and installation.

7. QUALIFICATION TESTING. Subject one sample of each type lighting unit to the tests described below. If desired, more than one unit may be subjected to the test series. This may be done to avoid interruption to the testing in the event of accidental damage to a unit in the course of the series.

a. Photometric.

(1) Check the optical performance of the unit to determine if the photometric output conforms with the requirements in paragraph 6b(4). Use test methods in accordance with FAA-E-1100a.

(2) Make a test to determine that the flash frequency is 120 ± 2 flashes per minute.

b. Synchronizing Equipment. Test the REILS and MALSF master timers to demonstrate that they operate in accordance with specification requirements.

c. Environmental Test.

(1) Temperature Rise. Test the complete sample unit within a room not subjected to excessive air movement. Energize the unit at rated voltage or current and flash it continuously at twice per second for a minimum of 48 hours. During the test, maintain the ambient temperature 55° C. minimum. Failure or deterioration of any components, skipping of flashes or more than two flashes per minute, is cause for rejection.

(2) Low Temperature. Place the light unit, power supply, master timer, and series adapter unit in a test chamber and lower the temperature to -55° C. After a four-hour period, operate the equipment at rated input at least 60 minutes while the ambient temperature is maintained at -55° C. or lower. Failure or deterioration of any components or improper flash rate is cause for rejection.

d. Input Power for Power Supply and Adapter. The maximum RMS volt-amperes at the input terminals of one combined power supply and adapter (if required for series operation) is 650 volt-amperes. Use measured RMS input volt-amperes for calculations.

e. Interlock Switches. Make a test to check satisfactory operation of all interlock switches in accordance with the requirements of paragraph 6e.

f. Dielectric. Perform a dielectric test on all power and control wiring. For control wiring use at least 1,000 volts, 60 Hz, AC applied for one minute between insulated parts and ground. Check power wiring in the same manner using voltages, 60 Hz specified in paragraphs (1) and (2) below. Where circuit components are not designed for a high voltage test, such as motors, condensers, rectifiers, etc., disconnect these items for this test.

(1) Type III and Type IV Units - 1,500 volts (minimum) 60 Hz.

(2) Adapter Unit - 5,000 volts (minimum) 60 Hz.

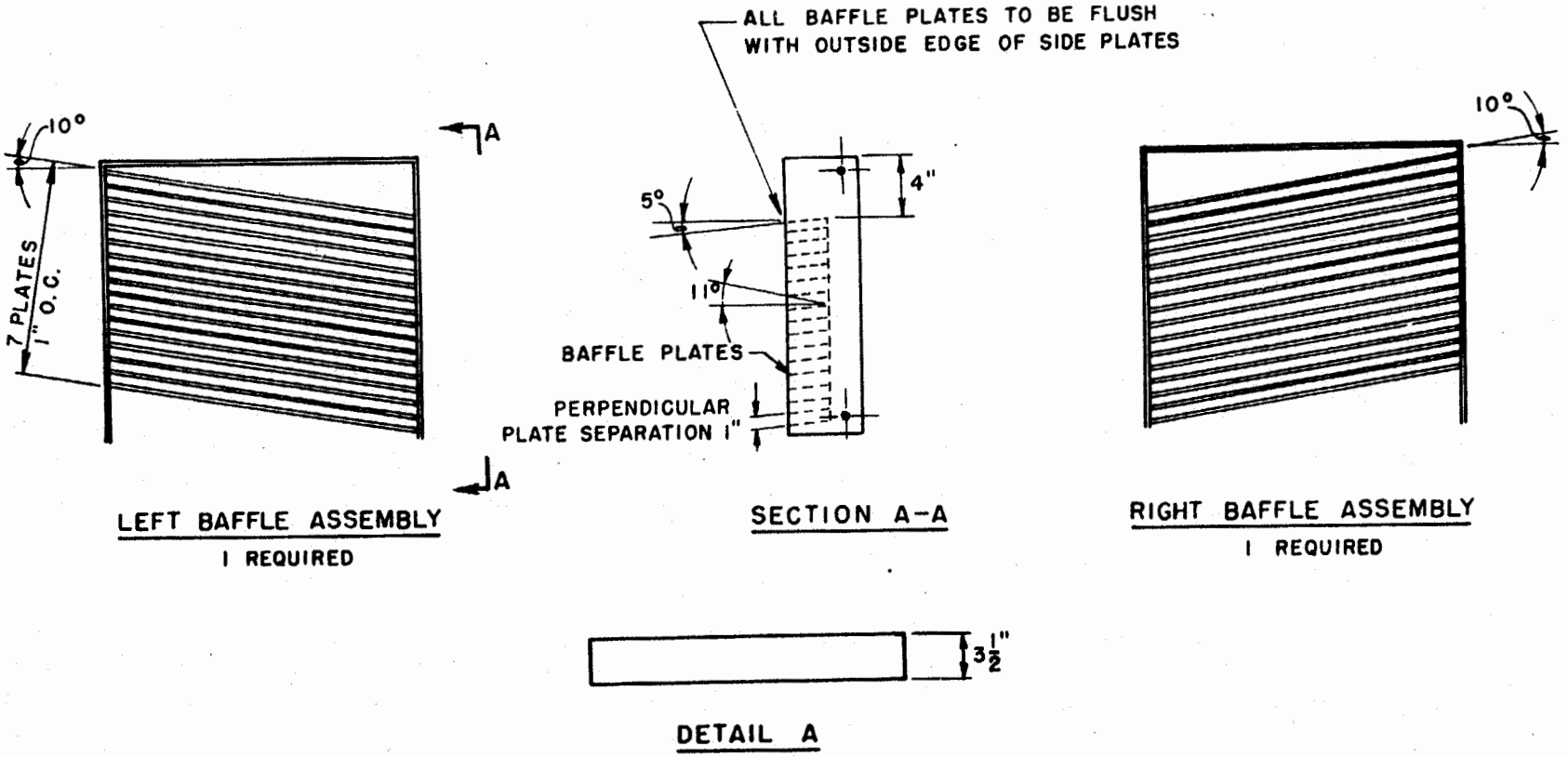
g. Operational.

(1) Connect an adapter (paragraph 4c) to the Type III or Type IV unit and operate the equipment in a 2.8-6.6-ampere series circuit. Use a constant current regulator to obtain the variable current. Connect at least one AC 150/5345-22 transformer with lamp and one AC 150/5345-31 transformer with lamp in series with the light unit. Any evidence of improper operation of the flashing light or visual pulsation of the series lamp connected across each insulating transformer is a cause for rejection.

(2) Check the Type III and Type IV units to demonstrate that they will operate satisfactorily within the voltage range of 120 volts ±6 volts and 240 volts ±12 volts, respectively, at 60 Hz ±3 Hz.

h. Additional Inspections and Tests. Make all additional inspections and tests considered necessary by the Federal Aviation Administration, Airports Service, Washington, D.C. 20590, to determine compliance of equipment and components with this specification.

8. QUALIFICATION. See Appendix 1, Section 4, for qualification requirements.



NOTES

1. MAKE THE SHAPE OF THE BAFFLE CONSISTENT WITH THAT OF THE REIL OPTICAL ASSEMBLY.
2. COAT ALL SURFACES OF THE BAFFLE ASSEMBLY WITH A BLACK NONREFLECTIVE OUTDOOR TYPE PAINT.
3. USE MINIMUM 12 GAGE B & S ALUMINUM ALLOY TYPE 5052 FOR BAFFLE MATERIAL.

SECTION 2, FIGURE 1. TYPICAL BAFFLE FOR REILS

SECTION 3. SPECIFICATION FOR L-854 RADIO CONTROLS

1. PURPOSE. This specification contains the requirements for a fixed tuned, crystal controlled, very high frequency (VHF) receiver.

2. REFERENCES. The applicable specifications (see Appendix 3) of the issue in effect on the date of application for qualification apply to this specification. In case of conflict, this specification governs.

3. MATERIAL AND WORKMANSHIP. Select components and materials of industrial quality or better. Use workmanship in accordance with high-grade commercial practice.

4. PERFORMANCE REQUIREMENTS.

   a. Environmental. Design and construct the receiver to operate indoors or outdoors. If used outdoors, provide a weatherproof cabinet and components to permit outdoor operation of the equipment at any ambient temperature, from a minimum of -40 degrees Centigrade to a maximum of +60 degrees Centigrade at sea level.

   b. Operational.

      (1) Design the VHF receiver to operate in conjunction with decoder equipment, a relay and a contactor, which in turn are used to control economy approach lighting aids. The contactor is not a part of this specification.

      (2) Make the operation of the receiver dependent on receiving five pulses within five seconds. The pulses of radio frequency (RF) energy are produced by pressing and releasing the microphone button of the aircraft's VHF transmitter. The decoder equipment used in conjunction with the receiver accepts only this code. The decoder permits a relay to operate the external contactor that controls the airport lighting circuits.

5. DETAILED REQUIREMENTS.

   a. Receiver. Design and construct the receiver to meet the applicable Federal Communications Commission (FCC) requirements.

b. Frequencies.

(1) Design and construct the receiver to operate a relay which in turn operates a contactor that controls the airport lights. Use the operating VHF frequencies for control of the lights as specified by the FCC rules and regulations. This includes 122.8 MHz as standard frequency. See AC 90-33 for details concerning VFR communications. Make the receiver insensitive to normal air traffic control communications on the assigned or adjacent frequencies.

(2) Sensitivity. Design and construct the receiver to have a signal plus noise over noise $\left(\frac{s+n}{n}\right)$ ratio of at least 10db with a 3 (three) microvolt input.

(3) Selectivity. Select the bandwidth at the six decibel (db) attenuation not less than $\pm$15 KHz from center frequency. Unless otherwise specified, make the bandwidth at 80db attenuation not more than 100 KHz.

(4) Spacing. Use the channel spacing of 50 KHz.

(5) Impedance. Make the input impedance circuit at the antenna 50 ohms (nominal).

(6) Power Supply. Design the power supply to operate from 120 volts +5 percent, 60 Hz. Provide adequate capacity and proper rating to permit proper operation under conditions described in paragraph 4. Provide a manual switch for on-off operation of the power supply.

(7) Audio. Make provision for the connection of an audio output for listening to the character of the received signal. The external audio circuit (not included in this specification) shall have suitable components and characteristics.

(8) Relay. Provide an integral plug in relay as specified in paragraphs 5d(2)(a) and (b).

c. Antenna. Provide a high grade, vertically polarized, commercial antenna to permit proper operation of the receiver under the conditions specified in paragraph 4b. Furnish 100 feet of coaxial transmission line. Make both of these items suitable for outside installation under the conditions specified in paragraph 4a. Make

the antenna, coupled with its feed line, present minimum loss of receiver signal at the receiver's input terminals. If required, provide a method in the antenna circuit to discharge excess static electricity due to the buildup during storms.

d. Activation, Signal, and Decoder.

(1) Activation and Signal. Unless otherwise specified, make the activation signal a series of five pulses of RF energy within five seconds. Pressing and releasing the microphone button of the aircraft's VHF transmitter produces these pulses. Make the RF pulse duration and space between pulses 1/4 to 1/2 second. Provide a manual push to test switch.

(2) Decoder. The decoder in the receiver circuit accepts only the code referred to in the preceding paragraph (1). The decoder permits a timing circuit and relay combination to close the two normally opened contacts of the relay for a period of 15 minutes. The relay contacts close within one second after the last pulse is received. Provide a reset to permit the receiver to be reactivated prior to the expiration of the 15 minutes. Reactivating the receiver during any part of the timing cycle restores a total time of 15 minutes. Provide a pilot lamp on the receiver to glow during the time that the receiver is activated.

(a) Relay Coil Rating. Select a relay with a coil rating compatible with the output of the receiver.

(b) Relay Contact Rating. Select a relay with two normally opened contacts rated to perform 100,000 operations minimum, making and breaking an in-rush current of 10 amperes at 120 volts AC. Select contacts rated to continuously carry a 4-ampere, 60 Hz inductive load.

(c) Warning Signal. Unless otherwise specified, provide a warning signal to indicate when the receiver equipment will turn airport lights off. Obtain the warning signal by providing a circuit to the lights "off" for approximately one second. Make this one second turnoff occur two minutes before the completion of the 15-minute "on" time cycle.

(d) Mean Time Between Failure (MTBF). Design and construct the receiver and its auxiliary circuits to provide 10,000 hours MTBF for the system.

(e) Parts List and Instructions. Furnish a component parts list and installation and maintenance instructions with each receiver. Provide sufficient drawings or illustrations to clearly indicate the methods of installation and maintenance.

(f) Nameplate. Securely attach a nameplate, which is permanently and legibly filled in with at least the following information, to the outside of the receiver:

(1) Identification: FAA-L-854

(2) Power Supply Voltage

(3) Control Circuit Current Capacity

(4) Frequency Range

(5) Manufacturer's Part Number

6. TEST.

a. High Temperature. Install a receiver in the weatherproof cabinet, energize the power supply and subject the receiver and accessories to an ambient temperature of at least 60 degrees Centigrade at 90 percent relative humidity for at least eight hours. Operate the receiver in consecutive cycles of 15 minutes "on" and 15 minutes "off".

b. Low Temperature. Install the receiver in the weatherproof cabinet, energize the power supply, and subject the receiver and accessories to an ambient temperature of at least -40 degrees Centigrade for at least four hours. Operate the receiver in four consecutive 15-minute on cycles at the completion of this test.

c. Operational. Check the qualification unit and production receiver and its accessories to determine if the equipment meets the detailed requirements in paragraph 5.

7. QUALIFICATION. See Appendix 1, Section 4, for qualification requirements.

SECTION 4. QUALIFICATION REQUIREMENTS FOR EQUIPMENT

Furnish sample equipment to an independent testing laboratory acceptable to the Federal Aviation Administration, Airports Service, Washington, D.C. 20590. Test the equipment as described in specification to obtain certification regarding the ability to manufacture lighting equipment meeting the requirements of the specification. Furnish two copies of the testing laboratory's reports to the Airports Service for review and approval consideration.

a. In addition to the test reports by the independent testing laboratory, furnish parts list, instruction books, and drawings to the Federal Aviation Administration, Airports Service, Washington, D.C. 20590, for review and approval.

b. Upon approval of the independent testing laboratory's test reports and the additional information and data required, which have shown satisfactory conformance to specification requirements, the Airports Service will list the name of the qualified manufacturer and a description of its equipment in AC 150/5345-1B, Approved Airport Lighting Equipment.

c. If the manufacturer has satisfactory laboratory facilities, the tests may be performed at the factory, and such tests shall be witnessed by a representative of the Federal Aviation Administration, Airports Service, Washington, D.C. 20590. The manufacturer shall furnish certified written reports of these tests for approval consideration.

d. The furnishing of products for Federal-aid Airport Program projects, which prove to be unequal to the approved equipment, will be sufficient cause for removal of the equipment and the manufacturer's name from the list of approved equipment.

e. At any time after approval has been granted under the above conditions, make available, upon written request from FAA, Airports Service, a certified copy of factory test reports on the latest production run of equipment.

f. Manufacturers shall not make a change of materials or manufacturing methods or revision of catalog numbers of approved equipment without prior approval of FAA, Airports Service, Washington, D.C. 20590.

SECTION 5. SPECIFICATION FOR L-859 OMNIDIRECTIONAL CAPACITOR DISCHARGE FLASHING LIGHT SYSTEMS

1. SCOPE. This specification contains the requirements for the omnidirectional lead-in approach light system (LDIN) and the omnidirectional runway end identifier light system (REIL).

2. REFERENCES. The documents listed herein, of the issue in effect on the date of request for qualification, are applicable to the extent specified.

3. EQUIPMENT COVERED BY THIS SPECIFICATION.

   a. The equipment covered by this specification are as follows:

      (1) Capacitor discharge light units consisting of a power supply and an optical head.

      (2) Control unit.

      (3) Instruction books.

   b. Other items required for a complete system installation such as power and control cable, remote control equipment, and light support structures are not covered by this specification.

4. SYSTEM DESCRIPTIONS.

   a. LDIN. The omnidirectional lead-in approach light system consists of seven omnidirectional capacitor discharge flashing lights located in the approach area of a runway. Five of the flashing lights are located on the extended runway centerline starting 300 feet from the runway threshold and at 300-foot intervals out to 1,500 feet from the threshold. The remaining two flashing lights are located approximately 40 feet from each edge of the runway at the threshold. The lights flash toward the threshold in sequence at a rate of once per second with the two lights at the threshold flashing simultaneously. The flashing lights are all controlled from a control cabinet that may be located up to 500 feet from the runway centerline.

   b. REIL. The omnidirectional runway end identifier light system consists of two omnidirectional capacitor discharge flashing lights located approximately 40 feet from edges of the runway at the threshold. The lights are controlled from a control unit that may be enclosed in one power supply housing (paragraph 10) or in a control cabinet (paragraph 11) that may be located up to 500 feet from the runway centerline. The lights flash simultaneously at a rate of once per second.

5. ENVIRONMENTAL CONDITIONS. The equipment shall be designed for continuous outdoor operation under the following environmental conditions:

   a. Temperature. An ambient temperature range from minus 55 degrees C. to plus 55 degrees C.

   b. Altitude. Any altitude from sea level to 10,000 feet above sea level.

   c. Humidity. A relative humidity range from 10 percent to 100 percent.

   d. Sand and Dust. Exposure to wind blown sand and dust particles as may be encountered in arid regions.

   e. Salt Spray. Exposure to salt laden atmosphere.

   f. Other Weather Conditions. Exposure to rain, snow, ice, hail, and sleet.

6. PHOTOMETRIC REQUIREMENTS.

* a. The capacitor discharge lights shall provide the following light distribution, at nominal input voltage, simultaneously and throughout 360 degrees in azimuth and throughout the area between 2 degrees through 10 degrees above the horizontal: *

   High intensity position - 5,000 ±2,000 effective candelas.

   Low intensity position - 700 ±200 effective candelas.

   b. The effective intensity for the low intensity position at zero degrees horizontal and below shall be kept to a minimum for environmental impact reasons and shall not exceed 200 candelas.

* 7. OPERATING REQUIREMENTS. Both systems shall be capable of being operated both remotely and locally. *

   a. For local operation, a switch shall be installed in the control unit to provide the following functions:

SWITCH POSITION	FUNCTION
Off	Power and control circuits to strobes deenergized.
Auto	System controlled (on-off and intensity steps) from remote location.
Low	System operating in low intensity position.

High	System operating in high intensity position.

b. For remote operation, the system shall be capable of being operated either by radio control or remote switches connected to the equipment by land lines. The necessary control relays or other devices shall be included in the control unit. The switching voltage and power for the radio control shall be obtained from the control unit.

* c. The omnidirectional lead-in approach light system shall flash in sequence at the rate of once per second starting at the outermost strobe unit and toward the runway threshold. The two strobes located on either side of the runway threshold shall flash simultaneously. The time between flashing of units shall be 1/15 of a second plus or minus 10 percent for those units located on the extended runway centerline. The time between flashing of the last unit on the centerline and the two runway end units shall be 4/15 of a second plus or minus 10 percent. The period between the last flash and start of a new cycle shall be approximately 7/15 of a second. *

* d. The omnidirectional runway end identifier lights shall flash simultaneously at a rate of once per second plus or minus 10 percent.

8. LIGHT UNITS. Each light unit shall consist of two parts, a power supply and an optical head, designed both for installation and operation as one integral unit and shall also permit, where required, remote installation of the optical head any distance up to 150 feet from the power supply. The size of the light unit, with the optical head mounted on top of the power supply, shall not exceed 24 inches in width by 24 inches in depth by 34 inches in height. Interlock switches shall be incorporated in both the power supply and optical head to disconnect all incoming circuits and to discharge the flash capacitors, upon opening the access cover, to a maximum of 50 volts within 10 seconds. In addition, the design shall provide for permanently connected bleeder resistors to discharge the flash capacitors to a maximum value of 50 volts within one minute in event of failure of the interlock switches. Means shall be provided to enable the interlock switches to be cheated with the cover open. *

9. OPTICAL HEAD.

a. The optical head shall be designed for installation three ways as follows:

(1) Directly on top of the power supply.

(2) To mount on a single vertical pipe (having an outer diameter of 2.197 inches to 2.375 inches).

(3) To mount on a single two-inch horizontal angle iron.

b. The weight of the optical head shall not exceed 15 pounds. Means shall be provided to permit leveling of the optical head.

c. The housing for the optical head shall be designed to enclose the flash lamp and reflectors and shall be completely enclosed. The optical window shall be made of glass or acrylic plastic.

d. The flash tube shall have a rated life of at least 500 hours when operated on the high intensity step. The effective intensity shall not decrease more than 30 percent during rated life and flash skipping (misfiring) shall be less than 1 percent with no consecutive skips. The color of light shall be white. Xenon gas emission meets this requirement. A certified statement from the lamp manufacturer is required to satisfy this requirement.

10. POWER SUPPLY. The power supply housing shall be an outdoor, rain tight enclosure designed to accommodate all of the necessary components and wiring and shall have adequate clearances to facilitate installation and maintenance. The housing shall be rigidly constructed and shall not distort or bend under normal methods of shipping, handling, installation, and maintenance. Material for the housing is optional but shall meet all requirements of this specification and be of a type normally used by industry for equipment of this type. The housing shall have a hinged door, of a size to permit all components to be readily accessible for maintenance. The door shall have provisions for locking with a padlock having an 11/32-inch diameter shackle. The housing shall be designed to permit installation in two ways, by mounting on two vertical pipes or shall also be provided with lugs to permit mounting on a vertical surface. The design for mounting on vertical pipes (having an outer diameter of 2.197 inches to 2.375 and furnished by others) shall employ the slip-fit method and securing hardware shall be provided.

a. Power Input. Input power to each power supply shall be 240 volts, ±10 percent, 60 hertz, single phase. Maximum power consumption per unit shall be 500 volt amps.

b. Control Inputs. Control inputs shall consist of three conductors as follows:

(1) One conductor, common to all units of the system, to activate the high intensity position.

(2) Timing conductor, separate conductor for each unit, to provide trigger pulse for the flash tube.

(3) Common conductor.

c. Cable Connectors. The power supply shall be designed so that the system can be installed without the need for junction boxes. Terminal boards shall be provided to accommodate two incoming power conductors, eight incoming control conductors, two outgoing power conductors, and eight outgoing control conductors. Terminal boards shall also be provided for the required cable connectors between the power supply and optical head.

11. CONTROL CABINET. The control cabinet shall be an outdoor, rain tight enclosure of sufficient size to accommodate all components as required for furnishing power and control functions to the flashing light assemblies. The housing shall be rigidly constructed and shall not distort or bend under normal methods of shipping, handling, installation, and maintenance. Either steel or aluminum may be used for the housing material. The housing shall have a hinged door with provision for locking with a padlock having an 11/32-inch diameter shackle. A doorstop shall be provided for holding the door open in the approximately 120 degree position. Louvers, if required for ventilation, shall be designed to prevent the entry of insects, rain, or metal objects. A panel shall be installed in the rear of the cabinet upon which all components are to be installed. Mounting bolts shall not protrude through the cabinet. The cabinet shall be provided with suitable mounting lugs to permit installation with the door in the vertical position. A ground lug shall be provided in the cabinet for a #6 bare ground wire. Space shall be reserved for field installation of conduits for all external cable connections.

a. Inputs. Power input shall be 240 volts, ±10 percent, 60 hertz. Control inputs shall consist of one conductor for on-off control and one conductor for intensity step position. Remote control of the system will be performed by equipment furnished by others.

b. Outputs. The control cabinet shall supply power, timing signals, and intensity step signals to the flashing light assemblies.

c. Local Control Switch. A switch shall be installed in the control cabinet to permit local operation of the system as described in paragraph 7.

d. Elapsed Time Meter. An elapsed time meter shall be installed in the control cabinet to indicate the number of hours of operation on the high intensity position. The meter shall indicate up to 999 hours and indicate time in hours and tenths of hours. The meter shall be of the recycling type and similar or equal to General Electric Type 909X85.

e. Master Timer. A timer shall be installed in the control cabinet to provide triggering pulses for the strobes. The timer shall provide a pulse of 120 VAC nominal to each strobe.

f. Circuit Breaker. A two-pole circuit breaker shall be installed in the control cabinet to permit interrupting incoming power.

12. COMPONENTS AND ASSEMBLY.

a. Fuses. All circuits shall be adequately fused as required.

b. Lightning Arresters. Lightning arresters shall be installed in the control cabinet and flasher power supplies for all incoming and outgoing conductors. Arresters are not required for conductors between the flasher power supply and optical head nor on control conductors which do not terminate within the power supply.

c. Wiring. All wiring shall be of adequate size and voltage rating and shall be neatly grouped, laced, and secured as required by good practices.

d. Solid State Components. All solid state components such as diodes, rectifiers, transistors, etc., shall be suitably protected against transients, either produced internally within the equipment or from external sources such as lightning surges or by power line switching surges.

e. Parts Ratings. All parts shall be of adequate rating for the application and shall not be operated in excess of the parts manufacturer's recommended ratings during operation of the equipment throughout the specified environmental range.

f. Maintainability. The placement, mounting, and arrangement of components shall be such as to permit normal maintenance operations and replacement of parts.

g. Workmanship. Workmanship shall be in accordance with the best industry practices for equipment of this type. All welds, seams, corners, edges, etc., shall be carefully constructed to eliminate sharp edges and burrs.

h. Terminal Blocks. All external wiring connections in the equipment shall terminate on adequately rated terminal boards incorporating corrosion-resistant, pressure type terminals.

13. MATERIALS.

a. Materials shall be as specified herein. Where materials are not specifically designated, they shall be in accordance with the best industry standards for equipment of this type. Metal parts shall be inherently corrosion-resistant or shall be suitably protected to resist corrosion or oxidation during extended service life. The use of dissimilar metals in contact with one another shall be avoided wherever practicable. However, if their use cannot be avoided, they shall be used in accordance with MIL-STD-33586.

b. All hardware, including nuts, bolts, washers, hinges, etc., unless otherwise specified, shall be 18-8 stainless steel.

14. IDENTIFICATION AND MARKING. All components shall be suitably labeled either on the component or on the chassis adjacent to the component.

a. Warning signs shall be permanently attached to access doors or other surfaces where required for safety reasons. These warning signs shall be capable of withstanding the specified environment. No decals may be used on exterior surfaces but may be used on interior surfaces. The caption generally will be "DANGER - HIGH VOLTAGE" but should contain cautionary maintenance procedures as appropriate.

b. Each control cabinet, strobe power supply, and optical head shall have a nameplate permanently attached, and containing the following information:

Name of equipment component.
Identification - FAA-L-859.
Rating - volts, amps.
Manufacturer.

c. The equipment shall be finished to meet the environmental requirements of this specification. The exterior color shall be aviation orange #12197, Federal Standard 595. The finished surfaces shall be free of blotches, scratches, and runs.

15. INSTRUCTION BOOKS. An instruction book shall be supplied as part of each system and shall contain the following information:

a. Information as to safety requirements while maintaining the equipment.

b. Theory of circuit and system operation.

c. Complete schematics and interconnecting wiring diagrams.

d. Photographs or mechanical drawings of each unit of equipment showing all component parts. All parts shall be keyed to correspond to the designation given in the parts list.

e. Complete parts list with each circuit component keyed to the designation assigned on schematics or wiring diagrams. Complete information shall be given for each part to permit ordering for replacement purposes.

f. Recommended preventive maintenance.

g. Trouble-shooting information.

h. Physical characteristics (weight, size, mounting dimensions).

i. Installation instructions.

j. Operating instructions.

16. QUALIFICATION PROCEDURES. Procedures for obtaining qualification approval are listed in Appendix 4.

17. TESTS. Successful completion of all tests specified below, except paragraph h, is required for qualification approval. Production units shall undergo the tests specified in paragraphs g, h, and i.

a. High Temperature Test. The equipment shall be placed in a test chamber at ambient temperature, then connected and operated to determine that no malfunction or damage was caused by faulty installation or handling. The temperature of the test chamber shall then be raised to 55 degrees C., with the equipment non-operating, and maintained for a period of 12 hours. The equipment shall then be operated and continue operating with the test chamber maintained at a temperature of 55 degrees C. for a period of 36 hours. Failure of the equipment to operate properly or deterioration of any component is cause for rejection.

b. Low Temperature Test. The equipment shall be placed in a test chamber at ambient temperature, then connected and operated to determine that no malfunction or damage was caused by faulty installation or handling. The temperature of the test chamber

shall be lowered to -55 degrees C., with the equipment non-operating, and maintained for a period of 12 hours. The equipment shall then be operated and continue operating with the test chamber maintained at a temperature of -55 degrees C. for a period of one hour. Failure of the equipment to operate properly or deterioration of any component is cause for rejection.

c. Rain Test. The rain test shall be in accordance with Method 506 Procedure I, of MIL-STD-810. The equipment shall be operated during the test and failure to operate properly or evidence of water accumulation within the equipment is cause for rejection.

d. Photometric Test. Tests shall be conducted on the strobes to prove conformance with all photometric requirements. Effective intensity shall be calculated as specified in Illuminating Engineering, Volume LIX, November 1964, "Guide for Calculating the Effective Intensity of Flashing Signal Lights."

e. Strobe Input. A test shall be conducted to measure input volt-amps to the strobe power supply as specified in paragraph 10a.

f. Visual Inspection. All components will be visually inspected to determine compliance with the specification requirements. Measurements or calculations, or both, shall be made in order to establish that the electrical and electro-mechanical parts, wire, and insulating materials used in the equipment will not be subject to voltages, currents, power dissipation, and temperature in excess of their rated values.

g. Operational Test. The equipment comprising a system shall be connected and operated for a period of one hour and all operating requirements shall be checked.

h. Effective Intensity. Each production unit strobe shall be tested to prove that the beam's effective intensity is within specification limits on both intensity levels.

i. Dielectric Test. A dielectric test shall be made on all equipment components after complete assembly. For power wiring, the test voltage shall be twice circuit voltage plus 1,000 volts, 60 hertz, applied for one minute between insulated parts and ground. Control wiring shall be checked in the same manner using 1,000 volts. Components not designed for such a test, such as capacitors, diodes, etc., may be disconnected for the test.

APPENDIX 3. BIBLIOGRAPHY

1. Obtain copies of the Federal specification and standard from the Business Service Centers of the General Services Administration Regional Offices.

   a. TT-E-489 - Enamel, Alkyd, Gloss (for exterior and interior surfaces).

   b. Federal Standard No. 595 - Colors.

* 2. Obtain copies of FAA-E series specifications from the Federal Aviation Administration, Airport Safety and Facilities Support Branch, ARD-420 Washington, D.C. 20591 *

   a. FAA-E-1100a - Photometric Test Procedures for Condenser-Discharge Lights.

   b. FAA-E-1328b - Visual Approach Slope Indicator Lamp Housing Assembly.

3. The latest issuance of the following publications may be obtained from * the Department of Transportation, Subsequent Distribution Unit, M-494.3, Washington, D. C. 20590. AC 00-2, updated triannually, contains the listing of all current issuances of these circulars and changes thereto.

   a. AC 00-2, Federal Register Advisory Circular Checklist and Status of Regulations.

   * b. AC 150/5000-3, Address List for Regional Airports Divisions and Airport District Offices. *

   c. AC 150/5300-2, Airport Design Standards - Site Requirements for Terminal Navigational Facilities.

   d. AC 150/5340-9, Prefabricated Metal Housing for Electrical Equipment.

   e. AC 150/5345-7, Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits.

   f. AC 150/5345-22, Specification for L-834 Individual Lamp Series-To-Series Type Insulating Transformers for 5,000-Volt Series Circuit.

   g. AC 150/5345-26, Specification for L-823 Plug and Receptacle, Cable Connectors.

   h. AC 150/5345-28, Specification for L-851 Visual Approach Slope Indicators.

i. AC 150/5345-31, Specification for L-833 Individual Lamp Series-To Series Type Insulating Transformer for 600-Volt or 5,000-Volt Series Circuits.

j. Handbook 6850.2, Visual Guidance Lighting Systems.

k. Handbook 6850.3, Visual Guidance Lighting Systems Installation Drawings.

l. Handbook OA P 8200.1, United States Flight Inspection Manual.

4. Obtain copies of AC 150/5370-1A, Standard Specifications for Construction of Airports, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Send check or money order with your request made payable to the Superintendent of Documents in the amount of $6.25 for each copy. No c.o.d. orders are accepted.

5. Obtain copies of Rural Electrification Administration (REA) Bulletin 345-14, REA Specification for Fully Color-Coded, Polyethylene-Insulated, Double Polyethylene-Jacketed Telephone Cables for Direct Burial, from U.S. Department of Agriculture, Rural Electrification Administration, Information Services Division, Washington, D.C. 20590.

6. Obtain copies of Military Standards and Specifications from Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

7. Obtain copies of Illumimating Engineering Publications from Illuminating Engineering Society, 345 East 47th Street, New York, New York 10017.